1986 DROUGHT IN THE SOUTHEAST UNITED STATES

HEARING

BEFORE THE

SUBCOMMITTEE ON NATURAL RESOURCES, AGRICULTURE RESEARCH AND ENVIRONMENT

OF THE

COMMITTEE ON SCIENCE AND TECHNOLOGY U.S. HOUSE OF REPRESENTATIVES

NINETY-NINTH CONGRESS

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1986 DROUGHT IN THE SOUTHEAST UNITED STATES

MONDAY, SEPTEMBER 29, 1986

HOUSE OF REPRESENTATIVES, COMMITTEE ON SCIENCE AND TECHNOLOGY, SUBCOMMITTEE ON NATURAL RESOURCES, AGRICULTURE RESEARCH AND ENVIRONMENT,

Cary, NC.

The subcommittee met, pursuant to call, at 9 a.m., in the National Institute of Environmental and Health Sciences Auditorium, Cary, NC, Hon. James Scheuer (chairman of the subcommittee) presiding.

Mr. SCHEUER. The Subcommittee on Natural Resources, Agricultural Research and Environment will come to order.

I am Congressman Jim Scheuer from New York and I am delighted to be here at this hearing with Congressman Tim Valentine of this community and Congressman Bill Cobey of this community, also.

This congressional Subcommittee on Natural Resources, Agricultural Research and Environment, has jurisdiction over a wide range of Federal environmental programs of all kinds, weather, climate programs, agricultural research programs and over the last 5 years we have held public hearings at many points in the United States on severe weather phenomenon, severe weather happenings and severe weather events that have taken their human and financial toll and environmental toll.

Now, these hearings have been very useful to us in Congress in helping us to understand, helping local, State, and Federal officials to understand how public and private entities can work together in helping communities to deal with some of the unpleasant and sometimes tragic events that mother nature holds in waiting for us and surprises us with from time to time.

In the past, hearings of this sort have given us the ammunition to preserve essential Federal programs like the Agricultural Weather Services.

We had extensive hearings on this around the country, especially in southern Florida; tornado preparedness programs here in North Carolina and hurricane spotting weather satellites. Today's hearing is a bit different than some of the hearings we have had in the past because instead of examining how to predict and how to deal with a sudden, intense weather event like a tornado or a hurricane, today we are going to deal with longstanding and continuing problems, the problem of the Southeastern drought of 1986.

Now, I understand that this was the most severe drought in a century, in fact, over a century, since 1885, when there was the toughest, most brutal and cruel, devastating drought in 101 years.

I further understand that this may be a harbinger, may be a predictor of perhaps 2 or 3 years of drought and that isn't just a one-time event. So our purposes here today are threefold.

First, we intend to review the impacts of the drought with scientists, with public officials and with your North Carolina citizens who have their hands-on experience to share with us.

Second, we will be able to review the ability of Federal and private agencies to respond effectively to drought conditions.

Third, we will take a long view and examine technologies and strategies which might prove useful in mitigating the effect of future droughts.

We know there will be future droughts. We hope that they will not occur with severity again in North Carolina, but the lessons that we learn here today may help all of us to deal better with the next inevitable drought.

At this point I would like to recognize my two colleagues for any statements that they would like to make before the witnesses begin.

Congressman Valentine.

I might say that Congressman Valentine is one of the most respected, admired and hard-working members of the Science and Technology Committee. He is known for doing his home work. He is known for knowing what he is talking about. He is known for his high intelligence and his uncompromising honesty and integrity and he has been an invaluable member of the Science and Technology Committee.

We are very proud to work with him.

Congressman Valentine.

Mr. VALENTINE. Mr. Chairman, I want to thank you very much for those remarks. I listened very carefully and I agree with everything you said.

I want to say to you seriously that we are pleased and honored to have you in our State and in our district and in a district so close to Congressman Cobey's bailiwick. We want to see to it, as best as we can see to it, that the story which we take back to the full subcommittee and full Committee on Science and Technology expresses the situation which exists from various points of view and makes recommendations or contains suggested changes or ways that the Congress cannot just discuss and debate the problem, but can make some serious and meaningful decisions with respect to ways to deal with this problem in the future.

Mr. SCHEUER. Excuse me, Congressman Valentine. I have got an urgent phone call. Would you continue on and when you are finished with your remarks, recognize Congressman Cobey and then continue with the witnesses?

Mr. VALENTINE. We certainly will, Mr. Chairman. Thank you.

Mr. SCHEUER. I will be back as soon as I can.

Mr. VALENTINE [presiding]. I am particularly pleased the Subcommittee on Natural Resources, Agricultural Research and the Environment is here in the Second Congressional District today to examine the effects of the worst drought, as the chairman has

stated, the worst drought in the Southeastern United States since 1885.

The subcommittee will also explore ways in which technology can help us to predict and cope with similar problems in the future.

I am grateful, as I have stated, we are grateful to our chairman for taking the time from his schedule to come with us, to be here with us and conduct this hearing.

I know I speak for all the people of our district in expressing to him, as I have stated, our personal gratitude. I also would like to express my appreciation to the chairman of the full Committee on Science and Technology, the Honorable Don Fuqua of the State of Florida, for encouraging the subcommittee to proceed with this hearing.

As some of you will recall, in 1984 North Carolina was hit by one of the worst tornados in the southeastern part of the United States, one of the worst to occur in over 60 years. Now those tornados were a personal tragedy for many thousands of people whose properties were destroyed and who, unfortunately, lost loved ones.

This subcommittee was called upon to visit the district at that time to ascertain more about the tornado phenomenon, Federal and State response, and the special problems any community faces in the wake of such disasters and solutions to those problems.

The subcommittee is being asked to investigate a similar, though less localized and more long-term disaster that has caused enormous economic hardships in the Southeastern United States and particularly in the State of North Carolina

To my knowledge, this is the first field hearing by any congressional committee in any area that has been affected by the recent drought or the continuing drought. Our subcommittee under Chairman Scheuer's leadership, has the responsibility for the budget of the National Weather Service.

In that capacity, we have slowed the wholesale contracting out of weather services so that we might consider carefully how best to meet our national needs in this area at present, and into the 20th century.

Today we will continue our oversight of weather services by examining how these services operated in response to the drought.

In North Carolina the 95-plus temperatures lasted for months on end, as everybody here knows. The heat wave dried up streams and caused hundreds of millions of dollars of agricultural losses, claiming farmers as its chief economic victims.

Further, as the drought drags on, other industries, including forest products and river transport, also are being harmed. The drought thus has had a ripple effect in which its disastrous impact spread from the farming sector to where it now affects the entire community.

This is a variation of a theme repeated all across the southeastern part of the United States this past summer, from Alabama and Georgia, north through the Carolinas. Since January 1, rain fall in most places has been less than 40 percent of normal, burning up more than $2 billion worth of crops, drying out wells and farm ponds and threatening municipal water supplies.

Many districts conserve water supplies through other restrictions and other neighboring cities and towns are forced to institute mandatory water restrictions. This was particularly true for the city of Chapel Hill which experienced acute water shortages throughout the drought.

Their problem became more acute when 20,000 students and faculty returned to the campus around mid-August. For a period of time there has been a high level of public recognition of the damage inflicted by this disaster.

This recognition was also acknowledged by the White House which designated North Carolina as the first southeastern State eligible for disaster relief.

When the rains came in August and early September, some of the public concern over the effects of the drought subsided. Some believe those rains relieved all problems and that everything has returned to normal.

However, this is not the case. The devastation inflicted on row crops, vegetables, livestock, and fruits and berries continues to cause economic difficulties and uncertainties. Assistance programs provided to farmers in the disaster designated areas have been directed more toward livestock and poultry farmers, with little help for other commodity producers.

The purpose of this hearing, ladies and gentlemen, this morning, is to hear testimony on the effects of the drought as well as on weather prediction and modification technology and drought related research being conducted by Federal agencies, such as the U.S. Department of Agriculture and the National Oceanic and Atmospheric Administration.

This investigation is intended to help farmers and others who are dependent on the weather to cope better with climatic changes. We need to examine new technologies to improve long-range policies to improve our forecasting capabilities and lessen the impact of future droughts.

The hearing 2 years ago on the destructive tornados ended with specific recommendations, such as better weather forecasting technologies and additional staff. To date the National Weather Service has placed a full time meteorologist at Raleigh Durham Airport, I think as a direct result of that hearing over 2 years ago. And the Congress has authorized funding for the next generation radar, Nexrad, which is the latest state of the art technology for weather predictions.

I hope that specific recommendations will be made today that will result in constructive action from Washington. In closing, I say again I want to thank the chairman of the subcommittee.

I want to thank my colleague, Bill Cobey, for coming here today and being a part of this hearing. I also want to express gratitude to the National Institute of Environmental Health Sciences for allowing us to use this splendid facility and to those individuals who have given generously of their time and effort to make this hearing possible.

In addition, I want to thank the staff of this subcommittee and full committee, some of whom are here today, for all the hard, difficult and effective work which they have done.

I recognize at this time my colleague, Congressman Cobey, fo. any opening statement which he cares to make.

Mr. COBEY. Thank you, Congressman.

I want to second what you had to say, particularly your closing remarks.

I want to thank you for inviting me to participate in this hearing and, Chairman Scheuer, for coming down here and allowing me to be a part of this hearing. Even though I am not a member of this particular subcommittee, I am a member of the full Science and Technology Committee, so ultimately I have to deal with this.

I think people can understand why Congressman Valentine and I feel like it is so important to be a part of the Science and Technology Committee, given the nature of our area and the direction that we are going in.

My district here in central North Carolina, was greatly impacted by this drought. All five of the counties that I serve were declared disaster counties.

Our office, through its involvement in contacting many Federal agencies, came to the conclusion that we need to build a better process to deal with these types of disasters and to learn how to work together as Federal, State and local agencies and governments. We also need to get on with the job of long-range planning and setting some objectives so that when this type of disaster occurs, hopefully never here in this area again, but somewhere else in the country, we will know how to effectively move.

So that is all my opening statement at this point in time. I do have a written statement that I would like to submit for the record, Mr. Chairman.

[The statement of Mr. Cobey follows:]

PREPARED STATEMENT OF CONGRESSMAN BILL COBEY

Good morning. By serving as the Congressman from the Fourth District of North Carolina, I represent an area of the State that was severely impacted by the drought of 1986. Just 2 months ago, we were in the throes of one of the worst droughts in this State's history. While the Government cannot prevent a drought, steps can be taken to learn from this so that appropriate action can be taken in the future. This is why we are here today.

I want to thank those of you who are attending this hearing, for taking the time to address a problem that we must handle. It is essential that officials at the Federal, State, and local levels join forces in order to ensure that the people of this area are equipped to take swift, effective action in responding to similar situations. In our efforts to assist during the worst part of the drought, we contacted a number of Federal offices including Secretary of Agriculture Richard Lyng, who was head of the Federal Drought Assistance Task Force, the Federal Emergency Management Agency, Department of Housing and Urban Development, and the Farmers Home Administration, to see if any assistance might be available. Our office was also in touch with the Orange Water and Sewer Authority to ensure that we stayed abreast of any new developments.

Plans must be developed on the local level so that the Federal Government can know how to assist. It is imperative that steps are taken to meet long-range goals and in order for that to be done, each level of government must work together. I am here to contribute to the discussion, but I am also here to listen so that should a situation such as the drought arise, no time will be wasted in implementing the procedure to alleviate the problem. Let this hearing be the first step in addressing a problem we cannot afford to lose.

Mr. VALENTINE. If you will let the staff have a copy of that, that will be made part of the permanent record of this hearing.

Thank you very much for that statement.

Mr. VALENTINE. The first panel will address, speak to and talk about the impacts of the 1986 drought. This panel consists—I will ask these gentlemen to come down and have a seat please and get fixed.

We are delighted to have you gentlemen with us today and we will hear from Mr. Pasquini first. You may feel free, of course, to summarize your statement.

We will see to it that the prepared remarks are printed in the record in toto, but we don't want you to summarize too much, because we want to have a full understanding of the real problems that have been encountered by Chapel Hill and this surrounding area that you are so familiar with.

Glad to have you here.

STATEMENTS OF DAVID PASQUINI, CITY COUNCIL, CHAPEL HILL, ACCOMPANIED BY EVERET BILLINGSLEY; LINDSAY T. WAGSTAFF, ROXBORO; AND ERNEST B. WOOD, JR., ROXBORO, NC

Mr. PASQUINI. Thank you.

I am a member of the town council of Chapel Hill, as you said. I would like to thank the subcommittee for the opportunity to discuss the effects of the 1986 drought on Chapel Hill. The town of Chapel Hill as well as the town of Carrboro in Orange County are provided water and sewer by the Orange Water and Sewer Authority, OWASA.

It was created by general statute and was created by joint resolutions of Chapel Hill, Carrboro, and Orange County to provide the necessary water and sewer facilities and resources for Chapel Hill, Carrboro, and Orange County. I have asked Everet Billingsley to present the opening statement to your subcommittee.

Mr. VALENTINE. Glad to have you here, sir. Please proceed.

Mr. BILLINGSLEY. Thank you, Mr. Pasquini, for asking me to present the statement on behalf of our community.

I thank the chairman and Congressman Cobey and Congressman Valentine for this opportunity. I will summarize a written statement which will be submitted for the record, Congressman.

Good water supply planning and timely development of additional water supply resources is the primary approach to meeting a growing demand for water or a drought. Since beginning operations in 1977, OWASA has been attempting to develop a major water supply reservoir on Cane Creek, located about 12 miles west of Chapel Hill.

If the permanent reservoir were in place at Cane Creek, the total system capacity would exceed 13 million gallons per day and the community would not have water supply problems now or for many years into the future. The efforts expended and the hurdles overcome to develop this local supply with strictly local funding have been formidable.

The timely development of this project would have meant the water supply shortages faced by the local community, and perhaps some adjacent communities as well could have been avoided. But the regulatory maze of EIA's, EIS's, SEPA's, NEPA's, 404's, 401's, condemnations laws, wildlife protection laws, dam safety laws and

a multitude of other requirements has unduly prolonged the timely development of this reservoir project.

On the one hand, these requirements have resulted in the need for repeated mandatory conservation measures, which have directly and indirectly adversely affected the entire local economy. The associated delays have substantially increased the costs of developing this badly needed supply.

On the other hand, these requirements have not necessarily resulted in an improvement in other public objectives, such as protection of the environment and private property rights. Clearly, in the case of OWASA, existing Federal and State laws have adversely affected the timely, orderly and economical development of a water supply project which will have major benefits for the region.

The extreme drought of 1986 had a significant adverse impact on all of North Carolina. Practically all residents and all economic sectors of the State, including the Chapel Hill-Carrboro community, were affected in one way or another. Devastating crop and livestock losses, impacts on aquatic life and the natural environment, and dramatic depletion of many ground and surface water supplies resulted from what was reported to be the most extreme drought in over 100 years.

At the local level, the drought required the unforeseen, unbudgeted water utility expenditure of approximately $60,000 which does not include the cost of water purchases from neighboring towns. It also does not reflect the adverse economic impact on local commercial establishments, such as car washes, landscaping enterprises and contractors, who had their use of water restricted. Mandated reductions in water use also resulted in substantial losses of revenue from unrealized water sales.

Faced with the prospects of an impending serious water shortage, on July 2 the voluntary conservation stage of the local five stage water conservation ordinance was put into effect. Mandatory water conservation restrictions were imposed on July 9, 1986, resulting in prohibition of car washing, curtailment of water available for new construction activity and stringent lawn and garden watering restrictions. Customer response to requests for conservation was extremely positive and water consumption declined by more than 20 percent, which is substantial based upon other communities' conservation experiences.

With the university scheduled to return to full session in late August, and an expected increase in water demand, OWASA evaluated several alternatives for increasing the supply of water to the Chapel Hill-Carrboro community. A staff report dated July 23, 1986, provided information concerning those alternatives.

OWASA decided to pursue further interconnections, or networking of systems to obtain additional supply. With the cooperation of the town of Hillsborough and the city of Durham, both of which also faced impending shortages, progress was made on implementing these interconnections.

As one emergency measure, OWASA staff identified privately-owned water sources which could be treated by the town of Hillsborough for subsequent delivery to OWASA through the existing 16-inch water line interconnection. Pumping and piping equipment was borrowed from the State Office of Emergency Management to

make the transfer of water from a privately owned quarry. There were numerous associated technical problems which OWASA had to work out on its own.

The pump borrowed from the State could not be used as anticipated and an attempt to use another pump which was borrowed from a contractor was unsuccessful. Finally, OWASA staff took an existing pump that was on-hand for another purpose and constructed a floating pump platform. More than 8 weeks after the project was started, this makeshift arrangement, which was supported by empty drum barrels and powered by a rented generator, finally began pumping water from the private quarry.

A second alternative explored by OWASA staff was that of obtaining water through the city of Durham from Lake Holt, a State-owned reservoir near the Butner community. OWASA executed agreements with the State of North Carolina and the city of Durham to purchase up to 3 million gallons per day of raw water from the State and receive treated water from Durham through two interconnections between the OWASA and Durham finished water distribution systems. The pump station improvements at Butner necessary for the implementation of this project were financed by OWASA and this alternative is now operational.

These emergency measures were put into place within about 8 weeks at a total direct cost to OWASA of approximately $60,000. Any significant additional supplies would have cost between $1.5 and $5.5 million to develop and would have required from 2 to 4 months to complete.

If a reliable, long-term weather forecast had been available that information would certainly have aided in planning for the drought. Unfortunately, such a capability does not appear to exist. Although OWASA monitors the Palmer Drought Index and the 30- and 90-day weather outlooks, such indicators and forecasts have their limitations.

OWASA has also evaluated in-depth the past 100 years of historical local monthly rainfall data, but that data has been found to be statistically unreliable for drought projection purposes. A reliable advance forecast would have made it easier to cope with the drought.

Local efforts taken were quite effective to the extent they were controllable. However, there were limitations on State and Federal assistance. OWASA received assistance from various State and Federal officials and agencies for emergency funding, expediting regulatory approvals, minimizing legal constraints, assisting with material procurement and encouraging and facilitating political and administrative cooperation necessary for implementation of the selected alternatives.

OWASA received assistance from the North Carolina Office of Emergency Management, to the extent it was available. In the similar widespread drought of 1977, Congress made available in an expeditious way drought relief funds through the Economic Development Administration.

It should be noted that most of the expense by OWASA were made for improvements on property not owned or under long-term control by OWASA.

With a knowledgeable and hard-working staff, and fortunately a currently favorable cash position, OWASA was able to implement some significant emergency measures on a relatively short-term basis. Smaller utilities, and perhaps even larger utilities, facing similar emergencies might have had even greater difficulty taking such action. In any event it is a complex, time-consuming and expensive task.

Drought conditions extract a high cost from both urban and rural economies. These costs deter or prevent sound economic growth, burden households, farms, businesses and institutions with unbudgeted expenses, reduce tax bases and increase government obligations. Expansive regions are in a weakened state of preparedness in the event of the onset of other major civil or political problems.

Our society and its institutions, including State and Federal Government, are inadequately prepared to predict, cope with and promptly respond to unusual, deep drought situations such as that which we are now experiencing in 1986.

Although there are in place State and Federal laws that provide the Governor, President, and other officials with the authority to take emergency action in response to water supply shortages, the utilization of this authority has been very infrequent.

There is no apparent organized governmental program in place at the State or Federal level that could promptly and effectively respond to a significant local or regional drought-related water supply problem. There is a clear need for a program which can respond to such problems in a timely manner, such as within a few weeks or at most a few months.

Although conservation of existing supplies and utilization of supply interconnections with other utilities that also have limited water sources has helped the local community cope with the current drought, continued dependence on these systems does not afford adequate long-term protection from extreme droughts.

The timely development of additional water resources, such as the Cane Creek Reservoir, must receive high priority. Federal laws and regulations can be streamlined and reduced to encourage and support local water supply efforts.

Federal funds should be available and accessible for the unusual circumstance. A nonbureaucratic, adequate civil preparedness program and implementation institution must be in place with sufficient resources to respond in an expeditious and satisfactory manner to a drought which is a natural disaster with more subtle, but perhaps as deep and more widespread adverse consequences than dramatic, catastrophic events such as tornados or floods.

[The prepared statement of Mr. Billingsley follows:]

PREPARED STATEMENT OF EVERET BILLINGSLEY

INTRODUCTION

As the provider of water and wastewater services to the 50,000 or so residents, and the businesses and institutions of the Chapel Hill-Carrboro community, including the University of North Carolina at Chapel Hill and the North Carolina Memorial Hospital, Orange Water and Sewer Authority (OWASA) is responsible for assuring the availability of an adequate supply of water for the community. Even under typical day-to-day conditions, increased costs of treatment, rapidly increasing capital

costs, increased potential for degradation of the quality of local water supplies, and more stringent monitoring requirements and quality standards, make this responsibility quite a challenging one. However, because of presently limited water supplies, this challenge is magnified many times over when an extreme drought occurs, such as that of the summer of 1986.

Good water supply planning and timely development of additional water supply resources is the primary approach to meeting a growing demand for water or a drought. Since beginning operations in 1977, OWASA has been attemping to develop a major water supply reservoir on Cane Creek, located about 12 miles west of Chapel Hill. If the permanent reservoir were in place at Cane Creek, the total system capacity would exceed 13 million gallons per day and the community would not have water supply problems now or for many years into the future. The efforts expended and hurdles overcome to develop this local supply with strictly local funding have been formidable.

The timely development of this project would have meant the water supply shortages faced by the local community, and perhaps some adjacent communities as well, could have been avoided. But the regulatory maze of EIA's, EIS's, SEPA's, NEPA's, 404's, 401's, condemnations laws, wildlife protection laws, dam safety laws and a multitude of other requirements has unduly prolonged the timely development of this reservoir project. On the one hand, these requirements have resulted in the need for repeated mandatory conservation measures, which have directly and indirectly adversely affected the entire local economy. The associated delays have substantially increased the costs of developing this badly needed supply. On the other hand, these requirements have not necessarily resulted in an improvement in other public objectives, such as protection of the environment and private property rights. Clearly, in the case of OWASA, existing federal and state laws have adversely affected the timely, orderly and economical development of a water supply project which will have major benefits for the region.

EFFECTS OF THE 1986 DROUGHT

The extreme drought of 1986 had a significant adverse impact on all of North Carolina. Practically all residents and all economic sectors of the State, including the Chapel Hill-Carrboro community, were affected in one way or another. Devastating crop and livestock losses, impacts on aquatic life and the natural environment, and dramatic depletion of many ground and surface water supplies resulted from what was reported to be the most extreme drought in over 100 years. At the local level the drought required the unforeseen, unbudgeted water utility expenditure of approximately $60,000 which does not include the cost of water purchases from neighboring towns. It also does not reflect the adverse economic impact on local commercial establishments, such as car washes, landscaping enterprises and contractors, who had their use of water restricted. Mandated reductions in water use also resulted in substantial losses of revenue from unrealized water sales.

MEASURES TAKEN TO MITIGATE THE DROUGHT

Faced with the prospects of an impending serious water shortage, on July 2 the voluntary conservation stage of the local five-state water conservation ordinance was put into effect. Mandatory water conservation restrictions were imposed on July 9, 1986, resulting in prohibition of car washing, curtailment of water available for new construction activity and stringent lawn and garden watering restrictions. Customer response to requests for conservation was extremely positive and water consumption declined by more than 20 percent, which is substantial based upon other communities' conservation experiences.

With the university scheduled to return to full session in late August, and an expected increase in water demand, OWASA evaluated several alternatives for increasing the supply of water to the Chapel Hill-Carrboro community. A staff report dated July 23, 1986 provided information concerning those alternatives. OWASA decided to pursue further interconnections, or networking of systems to obtain additional supply. With the cooperation of the town of Hillsborough and the city of Durham, both of which also faced impending shortages, progress was made on impelementing these interconnections.

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These emergency measure were put into place within about eight weeks at a total direct cost to OWASA of approximately $60,000. Any significant additional supplies would have cost between $1.5 million and $5.5 million to develop and would have required from two to four months to complete.

WEATHER FORECASTING CAPABILITIES

If a reliable, long-term weather forecast had been available, that information would certainly have aided in planning for the drought. Unfortunately, such a capability does not appear to exist. Although OWASA monitors the Palmer Drought Index and the 30-day and 90-day weather outlooks, such indicators and forecasts have their limitations. OWASA has also evaluated in depth the past 100 years of historical local monthly rainfall data, but the data has been found to be statistically unreliable for drought projection purposes. A reliable advance forecast would have made it easier to cope with the drought.

EFFECTIVENESS OF GOVERNMENTAL EFFORTS

Local efforts taken were quite effective to the extent they were controllable. However, there were limitations on State and Federal assistance. OWASA received assistance from various State and Federal officials and agencies for emergency funding, expediting regulatory approvals, minimizing legal constraints, assisting with material procurement and encouraging and facilitating political and administrative cooperation necessary for implementation of the selected alternatives. OWASA received assistance from the North Carolina Office of Emergency Management, to the extent it was available. In the similar widespread drought of 1977, Congress made available in an expeditious way drought relief funds through the Economic Development Administration. It should be noted that most of the expenses by OWASA were made for improvements on property not owned or under long-term control by OWASA.

With a knowledgeable and hard-working staff, and fortunately a currently favorable cash position, OWASA was able to implement some significant emergency measures on a relatively short-term basis. Smaller utilities, and perhaps even larger utilities, facing similar emergencies might have had even greater difficulty taking such action. In any event it is a complex, time-consuming and expensive task.

LESSONS LEARNED

Drought conditions extract a high cost from both urban and rural economies. These costs deter or prevent sound economic growth, burden households, farms, businesses and institutions with unbudgeted expenses, reduce tax bases and increase government obligations. Expansive regions are in a weakened state of preparedness in the event of the onset of other major civil or political problems.

Our society and its institutions, including State and Federal government, are inadequately prepared to predict, cope with and promptly respond to unusual, deep drought situations such as that which we are now experiencing in 1986.

Although there are in place State and Federal laws that provide the Governor, President, and other officials with the authority to take emergency action in response to water supply shortages, the utilization of this authority has been very infrequent. There is no apparent organized governmental program in place at the State or Federal level that could promptly and effectively respond to a significant local or regional drought-related water supply problem. There is a clear need for a

program which can respond to such problems in a timely manner, such as within a few weeks or at most a few months.

Although conservation of existing supplies and utilization of supply interconnections with other utilities that also have limited water resources has helped the local community cope with the current drought, continued dependence on these systems does not afford adequate long-term protection from extreme droughts. The timely development of additional water resources, such as the Cane Creek Reservoir, must receive high priority. Federal laws and regulations can be streamlined and reduced to encourage and support local water supply efforts. Federal funds should be available and accessible for the unusual circumstances. A nonbureaucratic, adequate civil preparedness program and implementation institution must be in place with sufficient resources to respond in an expeditious and satisfactory manner to a drought which is a natural disaster with more subtle, but perhaps as deep and more widespread adverse consequences that dramatic, catastrophic events such as tornadoes or floods.

Mr. VALENTINE. Thank you very much, Mr. Billingsley.

We will hear from the other panel members and then we will come back for questions.

We have next on the panel Mr. Lindsay Thomas Wagstaff of Roxboro, who will give testimony addressing the problem from the point of view of a farm operator or farmer. We are happy to have you here today, Mr. Wagstaff.

Mr. WAGSTAFF. Thank you, Congressman Valentine, Chairman Scheuer, Congressman Cobey. Thank you for the opportunity to be here today to discuss the effects of the drought on my farming operation.

I, Tom Wagstaff of Roxboro, NC, am a fourth generation farmer on a family farm in Person County. On our farm I raise approximately 85 acres of tobacco and maintain a herd of 350 Angus cattle. For cattle feed and supplemental farm income, I grow oat, fescue-clover, and sudan hay, corn for both grain and silage, barley, and wheat.

According to the North Carolina Department of Agriculture, drought-related agricultural losses exceeded $330 million as of August 14, 1986. These losses represent 8 to 10 percent of the anticipated 1986 farm cash receipts.

This drought, which has been referred to as the worst of the century has devastated farmers in North Carolina, especially those in the Piedmont and mountain regions. It could result in a bitter end for many farmers who have struggled under the burden of a heavy debt load.

On our farm the drought began in the spring of 1985. Due to low rainfall, small grain production was down approximately 66 percent from 1984 levels. Spring and early summer grazing was well below normal, and the rate of gain for my calves was down substantially.

After relatively normal rainfall throughout the summer of 1985, lack of rain continued to be a burden in the fall, and I encountered much difficulty establishing adequate stands of grasses in newly seeded pastures.

This year, 1986, has been a period of time that I will always remember. Below normal rainfall from January through July combined with the excessive heat during June and July burned my corn plants before they could ever begin to produce ears.

All pastures were scorched brown, and by the end of June I was feeding the entire cattle herd on a daily basis again. At this point

my feed supply was not the best due to having fed hay and grain the entire month of April.

Under normal conditions, I am able to stop feeding the cattle around the end of March because of the emergence of spring growth in the pastures. My corn was not of any value for grain so I began mowing the corn for hay and baled it up in big round bales. This was quickly consumed by the cattle, therefore, corn was a total loss to me, if you take into consideration that under normal conditions I do not have to feed cattle in the spring, summer, or early fall.

This baled corn plus some sudan grass that I planted did prevent me from having to sell feeder calves early or reducing my brood cow herd. If rain had not arrived in August, I would probably be completely out of feed by now, and would have had to sell my cattle and calves as well.

Cattle don't gain as much weight during hotter weather. Rather than eat, even if adequate feed is available, they become lethargic and tend to stay in the shaded areas. For all of these reasons, I believe that the drought was responsible for me losing approximately $50 of direct income per calf on my 1986 calf crop.

Under normal conditions maintaining a cow-calf herd does not take a great deal of time, in relation to direct management, during the summer months, but this year was much different. We labored constantly repairing fences where cows had broken down in search of grass, moving cattle from pasture to pasture, feeding them daily, and we even had to rebuild watering ponds that had gone dry in the pastures. Some of the pastures became totally unusable due to water giving out.

Tobacco production has been very stressful and costly because of the drought. In the early spring I decided to cash lease most of our tobacco pounds away from our farm for the first time ever. This decision was based on many factors, one of which was a drought forecast for the entire spring and summer.

I do not believe, though, that long-term drought forecast would have measurably softened the drought's effects, because most farmers have to plant crops to make any money, and I do not believe that the technology is available today to make major planting decisions on weather forecasts. If long range weather forecasts could be proven accurate, farmers certainly should use them as a management tool.

The average farmer that irrigated tobacco in Person County probably averaged irrigating 2.5 times at a cost of $40, $50 per acre per time irrigated. There is approximately 5,000 acres of tobacco in Person County of which 60 percent is irrigated.

This resulted in an added production expense of $375,000 in my county. All of the tobacco that was not irrigated, as well as some that was irrigated, is extremely late.

The farmers have had problems getting help to harvest the crop. Student help returned to school before any major harvesting took place, and a lot of the migrant workers have left our county to pick apples in other locations. With the potential of an early frost approaching a lot of tobacco is being harvested immature and green, and a lot of ripening agents are being used on immature tobacco.

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Because of the drought, high quality tobacco is not there in most cases.

Another effect of the drought on our farming operation is the large number of dead and dying trees. I feel that at least 2 percent of the mature pines have died as a direct result of the additional stress caused by the drought. I have been harvesting these scattered dead and dying trees as I have time.

If the drought continues this added stress may make pine stands more susceptible to the southern pine beetle and ips beetle in the spring of 1987. We have recently seen instances of considerable late activity of these beetles in Person County.

In addressing the effectiveness of local, State, and Federal governments as to their efforts to alleviate the effects of the drought, I would begin by saying that local government was not in a position to do anything.

I have gotten advice at the State level on making farming decisions and how to go about implementing them once they were made. I feel that the Federal Government is in a better position to help than any government agency, but what they have done has been "too little, too late."

I have the largest cattle herd in Person County and the local ASCS office cannot help me under the emergency feed program until all grain crops are completely harvested on my farm. Also, what little grain and hay that I harvested in prior years work to my disadvantage in getting assistance.

This is unfair because it works in direct conflict with sound management practices. It is my opinion that feed inventories from earlier years should not have any relation to losses from the 1986 drought.

The entire farm community needs low-interest loans made available to all farmers that have suffered losses, not just the ones that cannot borrow money from conventional lending institutions.

Many farmers that cannot borrow from conventional lending sources will be unable to recover from the crisis facing them, and farmers suffering the losses from the drought need the help of low-interest loans to maintain a positive cash flow. Total farm income in Person County declined from $31,944,468 in 1984 to $21,703,065 in 1985. In 1986, it is estimated that the county will be fortunate to reach much above $15 million. This represents a 50-percent decline in total farm income in just 2 years.

From this drought, I have learned it is wise to be prepared for the worst situation possible, both materially and emotionally. I have learned that farm families can conquer severe adversity through dedication and hard work while being under great stress. I sincerely hope that this prolonged drought situation will end soon, and that the tobacco program can stop being constantly attacked both in Washington and throughout the Nation.

[The prepared statement of Mr. Wagstaff follows:]

PREPARED STATEMENT OF LINDSAY T. WAGSTAFF, JR.

I, Lindsay Thompson Wagstaff, Jr., 38, of Roxboro, North Carolina, am a fourth generation farmer on a family farm in Person County. On our farm I raise approximately 85 acres of tobacco and maintain a herd of 350 Angus cattle. For cattle feed

and supplemental farm income I grow oat, fescue-clover, and sudan hay, corn for both grain and silage, barley and wheat.

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This drought, which has been referred to as the worst of the century has devastated farmers in North Carolina, especially those in the Piedmont and Mountain Regions. It could result in a bitter end for many farmers who have struggled under the burden of a heavy debt load.

On our farm the drought began in the spring of 1985. Due to low rainfall small grain production was down approximately 66 percent from 1984 levels. Spring and early summer grazing was well below normal, and the rate of gain for my calves was down substantially. After relatively normal rainfall throughout the summer of 1985, lack of rain continued to be a burden in the fall, and I encountered much difficulty establishing adequate stands of grasses in newly seeded pastures.

This year, 1986, has been a period of time that I will always remember. Below normal rainfall from January through July combined with the excessive heat during June and July burned my corn plants before they could ever begin to produce ears. All pastures were scorched brown, and by the end of June I was feeding the entire cattle heard on a daily basis. At this point my feed supply was not the best due to having fed hay and grain the entire month of April. Under normal conditions I am able to stop feeding the cattle around the end of March, because of the emergence of spring growth in the pastures. My corn was not of any value for grain so I began mowing the corn for hay and baled it up in big round bales. This was quickly consumed by the cattle, therefore, corn was a total loss to me, if you take into consideration that under normal conditions I do not have to feed cattle in the spring, summer, or early fall. This baled corn plus some sudan grass that I planted did prevent me from having to sell feeder calves early or reducing my brood cow head. If rain had not arrived in August, I would probably be completely out of feed by now.

Cattle don't gain as much weight during hotter weather. Rather than eat, even if adequate feed is available, they become lethargic and tend to stay in the shaded areas. For all of these reasons, I believe that the drought was responsible for me lossing approximately $50 of direct income per calf on my 1986 calf crop.

Under normal conditions maintaining a cow-calf herd does not take a great deal of time, in relation to direct management, during the summer months, but this year was much different. We labored constantly repairing fences where cows had broken down in search of grass, moving cattle from pasture to pasture, feeding them daily, and we even had to rebuild watering ponds that had gone dry in the pasture. Some of the pastures became totally unusable due to water giving out.

Tobacco production has been very stressful and costly because of the drought. In the early spring I decided to cash lease most of our tobacco pounds away from our farm for the first time ever. This decision was based on many factors one of which was a drought forecast for the entire spring and summer. I do not believe that long-term drought forecast would have measurably softened the drought's effects, because most farmers have to plant crops to make any money, and I do not believe that the technology is available today to make major planting decisions on weather forecasts. If long range weather forecasts could be proven accurate, farmers certainly should use them as a management tool.

The average farmer that irrigated tobacco in Person County probably averaged irrigating 2½ times at a cost of $40 to $50 per acre per time irrigated. There is approximately 5,000 acres of tobacco in Person County of which 60 percent is irrigated. This resulted in an added production expense of $375,000 in my county. All of the tobacco that was not irrigated as well as some that was irrigated is extremely late. The farmers have had problems getting help to harvet the crop. Student help returned to school before any major harvesting took place, and a lot of the migrant workers have left this county to pick apples in other locations. With the potential of an early frost approaching a lot of tobacco is being harvested immature and green, and a lot of ripening agents are being used on immature tobacco. Because of the drought high quality tobacco is not there in most cases.

Another effect of the drought on our farming operation is the large number of dead and dying trees. I feel that at least 2 percent of the mature pines have died as a direct result of the additional stress caused by the drought. I have been harvesting these scattered dead and dying trees as I have time. If the drought continues this added stress may make pine stands more susceptible to the Southern Pine Beetle and Ips Beetle in the spring of 1987. We have recently seen instances of considerable late activity of these beetles in Person County.

In addressing the effectiveness of local, State and Federal governments as to their efforts to alleviate the effects of the drought, I would begin by saying that local government was not in a position to do anything. I have gotten advice at the State level on making farming decisions and how to go about implementing them once they were made. I feel that the Federal Government is in a better position to help than any government agency, but what they have done has been "too little too late." I have the largest cattle herd in Person County and the local A.S.C.S. Office cannot help me under the emergency feed program until all grain crops are completely harvested on my farm. Also, what little grain and hay that I harvested in prior years work to my disadvantage in getting assistance. This is unfair because it works in direct conflict with sound management practices. It is my opinion that feed inventories from earlier years should not have any relation to losses from the 1986 drought. The farm community needs low-interest loans made available to all farmers that have suffered losses, not just the ones that cannot borrow money from conventional lending institutions.

Many farmers that cannot borrow from conventional lending sources will be unable to recover from the crisis facing them, and farmers suffering the losses from the drought need the help of low interest loans to maintain a positive cash flow. Total farm income in Person County declined from $31,944,468 in 1984 to $21,703,065 in 1985. In 1986 it is estimated that the county will be fortunate to reach much above $15 million. This represents a 50-percent decline in total farm income in just 2 years.

From this drought I have learned that it is wise to be prepared for the worst situation possible, both materially and emotionally. I have learned that farm families can conquer severe adversity through dedication and hard work while being under great stress. I sincerely hope that this prolonged drought situation will end soon, and that the tobacco program can stop being constantly attacked both in Washington and throughout the Nation.

Mr. VALENTINE. Thank you, Mr. Wagstaff.

The last witness on this panel is Mr. Ernie B. Wood, Jr., who will address this problem from the point of view of a businessman.

Now, if you could, Mr. Wood, if you could summarize, you can proceed in any way you are comfortable with.

I might say this to the panels who are waiting, if you just talk to us, use whatever part of your notes you would like to, but I want you to be comfortable, all of you, but I don't want you to feel like you need to read it all.

If you would rather just sit here and talk to us, that will be satisfactory.

Mr. Wood.

Mr. WOOD. Congressman Valentine, Congressman Scheuer, Congressman Cobey, thank you for the opportunity.

I would rather not read mine if that would be OK, directly. I would just like to talk with you a little bit about it, what the effects in the business community are. I will briefly tell you what my business is, I am a land surveyor. That is my business.

I own a small business. I have a small business in Roxboro that employs 12 people. The effects that I have felt with the drought have not been as such that I am feeling at this moment. If anything at all, I had a short-term gain this summer, due to the drought, but I do want to emphasize this was short term.

Most businesses in Roxboro or Person County—and I think this applies to all rural counties and communities in North Carolina—will not feel the effects of the drought until the growing season is over and the farm community has kind of settled up what they are going to do this year.

What we see in Person County from year to year is basically if the farm community has a good year, then most businesses make a

good year. This, of course, is being based on the fact that the economy of Person County is primarily based on agriculture.

I think this will be a very important year for the farm community. I don't think there is any question about it. It will spill over into the private sector. It will affect my business, retail sales, car sales, equipment sales, virtually any type of business in Person County, since most of us rely so heavily on agriculture.

Now, as far as steps that I have taken to kind of combat the drought, I took some steps last year that were quite accidental, I guess, as far as the drought would be considered. We took steps to take our business away from the dependency of the farm community.

So what we are doing now is working more toward a development concept in our business rather than working with boundary-type surveys or things that are affected by agriculture. Normally, I find along about November or December, when we should be doing a lot of surveys that are agriculturally related, that again if the farm community has had a bad year, we see a complete dropoff of this type of survey.

I expect this year any type of land or boundary surveys we will be doing related to the farm community will be related to bankruptcy or foreclosures, something along that line.

I don't expect to see a great deal of farmland trading hands this spring or in the late fall.

In summarizing, really, the thing that I want to really drive home and make a point of is the drought, I think, has finally shed light on rural America and the small rural counties that we have basically depended on a farm income and a farm-type community that has had a tough year for about the last 10 years and I think the drought—and for lack of a better term—is just going to put the death blow on quite a few of these farms in Person County. This may be the straw that breaks the camel's back.

Of course, if it is extended over the period of 2 or 3 years, I don't think there is any question that rural America is going to be in extreme trouble.

Thank you, gentlemen.

[The prepared statement of Mr. Wood follows:]

TESTIMONY OF ERNEST B. WOOD JR., TO THE SUBCOMMITTEE
ON NATURAL RESOURCES, AGRICULTURE RESEARCH AND ENVIRONMENT

Thank you for this opportunity to address this hearing on "Lessons From the 1986 Drought".

My name is Ernest B. Wood, Jr. I am a land surveyor by profession and operate a small business in Roxboro, Person County, North Carolina that employs twelve people.

Person County is what we refer to as a border county lying in the Northern Piedmont section of North Carolina with a population of approximately thirty thousand people. Although we do have a fair amont of industry in our county, the main stay of our economy is agriculture, primarily tobacco being first, then grain and live stock. I do not wish to attempt to try to explain in detail the effect the drought of the summer of 1986 had on the farm community, because I am not a farmer and have no expertise in this field. I only breech the farm topic as an attempt to correlate how a major disaster, such as the drought of 1986, will affect many businesses in a small rural county.

My business has of yet not felt the impact of the drought, and if my predictions are correct, we along with many other small businesses will not feel the effect until the tobacco sales are finalized. If anything, I achieved a short-term gain from the drought because my field crews missed very little work outside due to inclamate weather. However, I do want to emphasize short-term.

If past experience is anything to gauge this year's effect the drought will have on businesses in Person County, and I do believe it is, then many businesses will feel a hard impact of the drought. With my business, previous years have shown if the farm community has a good or average year, then the farmer is more apt to make a long term investment in additional lands or equipment or even a new home. Of course this puts more money in the local economy and other business enjoys growth along with the farm community, all this results in the trading of properties which in turn affects my business. On the other hand, if the farm community suffers a major disaster, then there is less money available for growth and expenditures, farm land prices go down and there is less trading of properties, therefore affecting my business on the negative end. Any economist will tell you that anytime you have an economy based on one product, and that product experiences a major deviation from the norm, then the effects are far more reaching and affect far more additional services and products than just the producer. This, Gentlemen, is what will occur in Person County and other rural counties throughout the area affected by this drought. Again, my business has not felt the hard realities of the drought to date, nor have many others, but I predict we will begin to feel it in the next few months to come. As to how heavy a burden these rural counties will carry, I have no idea, but in the past we have had some pretty tough years. For example, a car dealer I know has already told me truck sales are down and he does not expect it to improve. Farm equipment and product sales have been down. The outlook for this fall does not appear to be any better. I expect many farmers will not be able to pay for seed or fertilizer on grain crops that were a total disaster, therefore bringing home the effects of the drought to these merchants. Many will be re-mortgaging their farms, putting them further in debt and the ones that were already in trouble from past years and connot re-mortgage, I expect this drought will put the "Death Blow' on their operations forcing them into bankruptcy and leaving an untold amount of creditors

partially or totally unpaid. I expect to be doing very few farm related surveys this fall and winter and the ones we will do will likely be foreclosure sales.

Outside the farm community the general effects of the drought are also felt. I know of a businessman who operates a small engine repair service. In June, he told me sales were terrible, repairs were down and he was considering having to lay off two employees. An owner of an apartment complex in Roxboro has re-seeded the yard and replanted shrubs that were planted in the spring. He told me when it was first planted it looked real good but with the drought and malfunctions in the sprinkler system, the yard and shrubs just didn't make it. I worked on a new sub-division where the developer has sown seed to meet erosion control standards. After the third try this fall, he finally has a stand of grass. Not only did he accrue additional expenses with the seeding, but he also paid additional grading lost when the rain showers finally came and washed gullies into his ditches and slopes due to nothing growing on them to control erosion.

So, as you can see Gentlemen, the effects of a drought are numerous. Some of the problems and examples could only be related to rural agricultural counties, while others would affect any area within the drought region.

I am of the opinion that rural America, be it the midwest, California, New England, or the south, is usually hit the hardest because it is not as diversified as your larger metropolpolitan centers or centers of industry and manufacturing. In Person County, we cannot afford for any business to fold or go into bankruptcy. Unemployment is high enough in Person County, sometimes reaching double digit. What industry we have seems to be sound, but we have had some closings within the past year. Rural America's private sector cannot absorb but so much.

As far as any measures I have taken to combat the drought's effect, I have taken none directly related to this problem. About a year ago, my firm steered away from agricultural related services and more toward the development sector. I guess it could be said we took precautionary measures quite by accident. For example, I do not depend on the boundary type surveys as much as I do the engineering type that we are currently pursuing. For this reason I feel my business probably will not be hit as hard as in the past.

The possibility of long-term drought forecasting would definately help. For example, certain types of businesses could plan a better liquidation of inventory and not have unnecessary items on hand. Construction type businesses could better plan its direction. Water conservation could be better planned. Farmers could possibly predict the outcome of the crops and plan how to meet certain growing seasons or what steps to take with livestock. Any long-term forecast or information on weather conditions would certainly be a big help to the private sector.

I certainly don't expect miracles and often feel that Government is called on to do the impossible. Certainly your local, state and federal governments are just as concerned about drought conditions as anyone. But I do not know what they can do to bring rain in a drought. I feel local government does the best it can by trying to institute conservation control. The state and federal government fund many research projects and weather related information networks to gather weather data. I very much encourage them to continue. Mother Nature is a tough old girl to deal with and more so un-co-operative than co-operative.

Science and technology are the greatest tools of knowledge that mankind has. The more we know about our world and what effects nature will have on it, the better we will be prepared to meet the future. I would encourage you, members of this subcommittee, to seriously consider additional appropriations for weather and climate study. I trust you, as our representatives, are concerned and will do all in your power to help us solve this serious problem of drought which on a long-term basis will be detrimental not only to rural America, but will affect everyone in this nation and in the world.

Mr. VALENTINE. Thank you, Mr. Wood.

Thank you, all the panel. I don't suppose—this was not the subject of our inquiry today, but I suppose it would be very difficult to make an assessment as to another problem created by this phenomenon; that is, what it does to that man and his wife and his family when things are so dry that even part of his pine trees, which send a long tap root way down deep in the Earth, he knows that things are so bad that he is going to even lose a part of his timber crop and all the other things that long periods of hot, dry weather bring to us.

Mr. Wagstaff, you mentioned something about the ASCS office. I just wanted to give you an opportunity to kind of underscore that and maybe dramatize it a little bit more for the record.

Without unnecessary repetition, could you tell us a little bit more about what you think that the ASCS office in Person County could have done to help you that they were not able to do or that they did not do?

Mr. WAGSTAFF. Well, Congressman Valentine, I would say that the main thing that the local ASCS office needs to be able to do is to act fast when we have a situation like this.

I think that we need to have Federal programs that are already implemented that can go into effect if they are triggered by a situation such as this again.

I have applied on all of my farmland for whatever assistance was available and I think they are doing all they can, but, certain things have to take place before they can act.

As I mentioned, all of my grain has to be harvested. I still have some corn that is in the field that has not been harvested yet. Until that takes place, they cannot give me any assistance under this emergency feed program because the so-called feed on hand has got to be figured up exactly before they can put the formula and get the results out of the computer.

Mr. VALENTINE. If we had been able to predict with reasonable certainty that if the weather service had been able with reasonable certainty, to say to you and other farmers that this is going to be a drought year, if you had known that and been able to know it, say, 5 years ago that there was an 80-percent chance that things would be this year as bad as they were, I think you have maybe alluded to this, but is there really a lot that you could have done—or let me direct your attention maybe in a little bit different way about that.

Could you have dammed up another stream somewhere or built another pond and prepared yourselves to irrigate or any other way you could have prepared for that eventuality?

Mr. WAGSTAFF. Certainly I think I could have done some things a little differently. I would have rebuilt some of my watering ponds in the pastures maybe at an earlier point and that would have alleviated some of the problems that I encountered from water giving out.

I could maybe have made some solutions to that problem. Farmers are eternally optimistic, though. You always think——

Mr. VALENTINE. And independent.

Mr. WAGSTAFF. That is right. You always think that it will rain and you always think you will be blessed by getting that shower on your farm even if it doesn't come anywhere else.

So we have to plant crops to feed our cattle and we have to plant crops to make money, so I would have maybe cut back somewhat on the acres that I planted of the various crops, but I don't think as far as planting I would have done a lot different.

Mr. VALENTINE. Because of the size of your operation, you would have been in a better position to take some measures to protect your interest than the guy who farms 50 acres or so, wouldn't you?

Mr. WAGSTAFF. Sure. I think that being a cattle farmer that you always have to remember that situations like this can occur and you have to have lots of feed on hand at all times.

That is why I am vitally opposed to this regulation with the emergency feed grain program of feed on hand being held against you. You need to have this as insurance, just like you need to save money in case you need it later.

I still suffered the same loss that anyone else would have suffered, irregardless of how much feed I had on hand.

Mr. VALENTINE. What is the size of your operation approximately?

Mr. WAGSTAFF. Well, I have got around 350 head of cattle. I have probably got a thousand acres of pasture land. Generally, we tend anywhere from 60 to 100 acres of tobacco, but as I mentioned, I lease it out, leased it out this year, most of it.

Of course, we have got a lot of timber land.

Mr. VALENTINE. How dependent are you on migrant workers?

Mr. WAGSTAFF. I have always tried to get by in the past without using migrant workers. I feel like in our county we have a high unemployment rate and I feel like these people that are unemployed should be working on the farms rather than bringing in migrant labor.

That is just my personal opinion. I think, though, that the situation has gotten in my county that it is almost impossible to raise a large crop of tobacco without migrant labor.

A lot of the school kids who used to help in the crop are working at other jobs such as Hardees or places like that where they can get more hours in and, of course, it would be an easier type work.

Mr. VALENTINE. Mr. Billingsley what is Chapel Hill's major supply of water? Does it come from deep wells or do you get your water out of one of these lakes in this area?

Mr. BILLINGSLEY. As far as surface impoundment, University Lake was filled in 1930. That was built when the university had 2,500 students and the town had 2,500 population. Now we have a tenfold population that we are serving, somewhere around 50,000, and we would have another supply if there had not been a multitude of impediments, which I stated to you earlier.

Mr. VALENTINE. Do you have any problem with—we have been in touch with officials in this area about this matter, about this problem. Is there anything about the way the local, State, or Federal Government has reacted to your particular problem that you would like to express in more detail?

Mr. BILLINGSLEY. I believe the people involved, representatives and the staff members of the representatives, have been very sensi-

tive and very responsive to the problem. What I am concerned about is that the program is not there.

The institution is not there so that when we call on your good offices for assistance and those of our State, that there is nothing really in place that you can offer in a most responsive way except a lot of sympathy.

Mr. VALENTINE. Do you remember any problem similar to this back in your adult life in Chapel Hill?

Let me back up and ask you how long have you lived in Chapel Hill?

How long have you been involved in this with the town council?

Mr. BILLINGSLEY. Twenty years. I am not on the council. I am the executive director of the water authority.

Mr. VALENTINE. I meant involved with them. Have you seen anything approaching this problem in the length of time you have been in Chapel Hill?

Mr. BILLINGSLEY. The drought of 1976, 1977, a 2-year drought, was a serious drought. The population was smaller. We were able to respond better, but that certainly forewarned us of things to come and we attempted to take some measures to prevent this, both from the point of good water supply planning and the unknowns of droughts.

We just don't know what is going to happen and the multitude of regulations that have been put together over the years for very good purposes now have become quite complex; and if we are going to be able to work through these drought situations by preplanning, then we have got to look at the rules that we play the game under.

Mr. VALENTINE. Are these the additional rules that we have to contend with now, is that one of the reasons you were not able to contend with the situation this time as well as you were back in the seventies or was it a population increase or what?

Mr. BILLINGSLEY. Well, it is a population increase and a situation where the plans that were laid in order to be able to handle these droughts, we were not able to implement them. When you are not able to do that, then you have to come and try to seek these emergency measures and we find that the emergency measures are not in place.

So my main concern is that the first thing that we do is to try to have a system that is coordinated and supported by all levels of government and the private sector to plan for these unknowns and variances in the weather, and then when we have these abnormal circumstances to have the programs and institutions in place to help those in a very expeditious way.

Mr. VALENTINE. Mr. Wood, while your business might have been affected directly or immediately, a lot of businesses would wouldn't they?

Mr. WOOD. Yes, Congressman Valentine.

For example, a direct effect that I know has involved a neighbor of mine who runs a repair and sales service. He told me due to the drought in June his sales were down so bad he was considering having to lay off two of his employees.

Another example would be a particular subdivision that I worked on, the developer I know sewed his erosion control three times

before he got it to grow. In the meantime, when we finally did get some rain after the second sowing, he also experienced a loss with additional grading cost due to the wash out that occurred and the fact he did not have any growth on his denuded areas when it did eventually come.

Mr. VALENTINE. Trees have been—in parts of this country and even in the Southeast—have been alive for many hundreds of years and our colleague in the Congress, Mr. Lindsay Thomas from Georgia stated to a group of us that some borings that had been taken on the old trees in south Georgia and other evidence indicated in that part of the world this past spring and summer was the driest period of time since the 1600's, which is amazing.

I don't think we were served quite that badly in this area, but when you compare a tragedy of this kind, and when you are able to say with a reasonable degree of scientific certainty this is the worst since the 1600's, that is pretty bad.

Mr. Cobey, did you have any questions?

Mr. COBEY. I just have one. I want to thank the panelists for coming here this morning and participating in this hearing.

I, too, have lived nearly 20 years in Chapel Hill, so I have watched this problem.

Should I infer from your testimony, Mr. Billingsley, if the Cane Creek Reservoir was in place that Chapel Hill, Carrboro, and Orange County, could have made out well through this drought?

Mr. BILLINGSLEY. Yes, Congressman.

Mr. COBEY. Without even having to bring water from other communities?

Mr. BILLINGSLEY. That is correct. The point I am trying to make is there is an obligation on all of us to do a good job of preplanning and implementation in anticipation of the uncertainties that nature brings on us through the weather. Even when we do a good job of preplanning and putting things into place, we are still going to be confronted with emergency situations.

So in that event, we need to have the assistance there in the Federal program.

Mr. COBEY. I agree with you on that. I am just trying to get to the point if this reservoir had been in place, then you would not have had the problems; would you have even had to have put in mandatory or voluntary conservation?

Mr. BILLINGSLEY. No, it would not.

Mr. COBEY. It would not have. So that gets back to the point you have made and I have watched you fight this regulatory maze, it seems like forever, to get the Cane Creek approved. If we had not had this regulatory maze, Cane Creek could have been in place several years ago.

Then this particular problem would not have been there, really.

Mr. BILLINGSLEY. That is correct. I do not want to leave the impression that we are opposed to the purposes of each of these particular regulations that I have referred to, but they have been put on the books over a period of time and now, together, they present a maze that not only ourselves but I have seen other utilities have to wade through in an attempt to be prepared for a drought situation.

Mr. COBEY. Well, I would believe you, Mr. Billingsley, and OWASA are probably experts at this time as to how to get something approved. I know personally I would appreciate it and I think other Members of Congress would appreciate if you could tell us how we could streamline this system so that it wouldn't take so long to meet the long-range water needs of particular counties.

So I look forward to you giving us some expert advice as to what we can do.

Mr. BILLINGSLEY. Thank you. I will be glad to forward comments to your office, other offices if—or make a comment now, whatever is your pleasure.

Mr. SCHEUER [presiding]. No reason why you should not comment now. That is what we are here for.

Mr. BILLINGSLEY. In years past a lot of unacceptable things were done in our country to the environment and we are not proud of those things. There was desecration of the environment by many people and something had to be done and we are all supportive of that.

It was at the local level, the State level, and the Federal level that the citizens demanded it and that the government responded. But in doing that, over the years there has been put into place the National Environmental Protection Act, the State Environmental Protection Act, and then the regulations that support those acts and the purposes are good, but there needs to be a coordination between State and Federal Government as well as an examination within the Federal Government and within the State government and perhaps even the local government of how we can accomplish those basic objectives that we set out to accomplish, without creating a maze that costs us in time, it costs us in money, it costs us in litigation through the courts and then we get into a situation such as this year, 1986, were we have a severe drought, or a year where we have even a less severe drought than this, and we are not prepared for it.

So then we come and look for emergency aid, tax dollars or additional—the increasing rates to our customers so what we need to do is work together to be prepared for these emergencies to the very best that we can and not let those laws and regulation that are put on the books for our protection become a milestone around our neck and meet the objectives in another area.

Mr. COBEY. That is all I have.

Mr. VALENTINE. Mr. Chairman, do you have any questions or any statements?

Mr. SCHEUER. Well, I thought that was a very thoughtful statement you just gave us, Mr. Billingsley. Do you want to expand it?

What are the kinds of things that the Federal Government and the State governments can do that are cost effective that from your point of view—a guy with hands-on experience—will work at reasonable cost?

Mr. BILLINGSLEY. I grew up on a farm.

Mr. SCHEUER. It shows.

Mr. BILLINGSLEY. I wandered the woods for many years before I departed there from and we should protect the environment. The National Environmental Protection Act was very important. But then we have a State act that almost duplicates that act.

So in the Cane Creek Reservoir project, in order to get a 404 permit from the Corps of Engineers, we had to develop a lot of environmental information. That was considered and then it was decided that an environmental impact statement should be written by the corps.

That took a long time. It was being challenged in the court. That was accomplished and the corps provided the 404 permit. But then it went through the State and the State had to replicate the same process.

They used much of the information that was developed in the Federal document, but then they developed their own information. That is a waste of public money. It is a waste of time. It is a waste of our customers rates and it has not accomplished double the purpose for double the work.

Mr. SCHEUER. What is your suggestion for remedying that, please? How can we streamline the process and prevent this kind of duplication?

Mr. BILLINGSLEY. It seems rather simple, either the Federal Government has to say they won't require it if the State governments will require it or the State governments have to say they will not require it, that type of document, if the Federal Government does.

Mr. SCHEUER. If the Federal Government is already requiring it.

Mr. BILLINGSLEY. It seems so simple.

Mr. SCHEUER. Those are sometimes the things that are difficult.

I am going to ask the two businessmen in the private sector a question. I am going to read you a quote from today's papers. It is a quote from a U.S. Senator from the State of Iowa.

> If a foreign country were doing to our farmers what this Administration is doing, we would have nuked them long ago.

Do you have a reaction?

Mr. WOOD. I think that is a pretty sound statement.

Mr. SCHEUER. How about you, Mr. Wagstaff?

Mr. WAGSTAFF. I have thought about this a lot and I am at a loss as to really what the Federal Government could do to remedy the problems on the farm. I don't think what you are doing is particularly helpful because the supports for the various grain programs, they aren't helping, I don't think.

The farmers are just tending to plant maybe a few less acres and they believe that if they get some subsidies from the Government, this will, at worst, make them break even on the crop. I think that is the attitude they are taking, which that isn't helping.

As far as the relief, as far as the aid we are getting, we haven't gotten anything yet. We have just gotten a lot of talk about what is going to happen and what we may get, so I think that is a reasonable statement.

Mr. SCHEUER. It has been an excellent panel. I appreciate your testimony.

Mr. VALENTINE. I thank you gentlemen—we, of course, expect the same things from the others who testify—have really given some food for thought.

There have been things said here that are hard to say. There have been some things that you have alluded to, Mr. Billingsley—I know what you mean and all of us do—but politicians, nobody

wants to talk about some things that are just so terrible that—politicians don't even use the word "taxes." It is referred to as revenue enhancement.

The thing that you spoke about, we are past the time, I think, in this country where we will stand for the desecration of the things that the Lord and nature put here. We are all interested in preserving the environment, seeing to it that our insecticides we use on crops don't destroy the beautiful birds that fly around in the heavens.

Every now and then we come face to face with a conflict of interest, don't we, as to how much attention we will give to that pristine stream that flows close to Chapel Hill when there is a desperate need for it to be dammed up so it can provide an adequate water supply.

I don't want anybody to get the impression that old Valentine said he was going to dam up a pristine stream over there close to Chapel Hill, but we do need to be very careful. Sometimes it is easy for some of us well-meaning folks, but in the Congress and outside of Congress, to go off screaming in one direction forgetting the other things that we have to contend with also.

I know that you see that and you appreciate it because of what you could do now and because of the way you were raised. Farmers in this country were the first conservationists.

Thank you all very much.

Next we have Mr. Thomas Karl. We are glad to have you here today. Your testimony will appear in the record in toto, so if you could summarize for us, we would appreciate it.

STATEMENT OF THOMAS R. KARL, NATIONAL CLIMATIC CENTER, ASHEVILLE, NC

Mr. KARL. First off, I would like to thank the committee for inviting me today to put the drought in the Southeast in some kind of historical perspective. In order to do that, I think there are two things we have to keep in mind when we talk about drought.

There is a drought that can affect the agricultural community, which we may refer to as an agricultural drought, and then there is another kind of a drought, a longer term drought that I will refer to as kind of a hydrological drought that would be related to the conditions that would be reflected in streams, lakes, and reservoirs.

If we take a look at the drought in those two areas, one of the things that is clear is that in terms of the hydrological droughts, let me summarize in terms of climatological characteristics. It was an unusual event. You can look at the hydrological perspectives of the droughts a number of different ways, and depending on how you look at it, you come up with recurrence intervals—that is how likely would a similar kind of drought like this be likely to occur in some of the areas in North Carolina, in Georgia, South Carolina, how likely would they occur in the future, given there was no change in climate.

Depending how you look at the situation, you can come up with recurrence intervals between 20 and 60 years for long, cumulative departures from normal in terms of precipitation or you can get

return periods of the order of a couple hundred years if you look at in terms of the intensity of the current drought we just had.

If you take a look at the drought in terms of the agricultural characteristics, it truly was a remarkable event. If you look at the growing season departures of moisture anomalies, from March through July, it truly is an unprecedented event.

We get recurrence intervals of several hundred years in some of the most severely impacted areas of North Carolina. So one of the questions that immediately one raises when you get these kinds of rare events—and I might mention that rare events sometimes do occur without any changes in climate—but one of the questions that you frequently run across is, does this portend a real change in climate?

Is there something different now that is going on that has not gone on in the past?

In order to do that, one of the things I would just like to remind everyone here of is we did have a very serious drought in our country in the 1930's related to the Dust Bowl days. If we take a look at some of the conditions in that part of the country, look at it in the same way we have looked at the drought in North Carolina, we find that in those areas during that very dry period recurrence intervals much the same as what we are finding in North Carolina, in fact, in some instances even longer.

Yet, if you look at those areas right now they are coping with too much rain. Lakes in many areas of the Midwest and Western part of the country are exceeding their banks, Great Salt Lake and Great Lakes to name a few.

So I think we have to realize that what is ongoing right now is part of what climatologists may call a climate fluctuation. That is, if we look at the past climate record, we find periods, 10-, 20-, 30-year long periods where the climate seems to shift to a different regime. We are not exactly sure why these shifts occur.

We can explain them in terms of changing jet stream patterns and sea surface temperatures and tropical storm activity and that kind of thing, but the real question is just why does the climate reach this kind of equilibrium over these long periods.

What particularly makes the drought in the Southeast noteworthy is that we have just come off of a period in the late fifties, sixties, and up through the late seventies, of very ample moisture throughout the Southeast, more than we have had in the past 100 years. So we were indeed fixed in a 20-, 30-year climate fluctuation where we were used to more rainfall that we have had in the last few years.

Again, I might mention if you remember, we had a drought in 1980, 1981 in the Southeast and the current drought really had some break in it last fall due to some tropical storm activity, but things were dry down here even in 1984 and parts of 1985 before the recent 1986 dry conditions.

So in total, I think the big question is just what is causing these climate fluctuations. The answer to that is we are not exactly certain, however, there is no evidence to suggest that these fluctuations are caused by anything that man is doing right now, for example, the carbon dioxide greenhouse gas phenomenon.

We do have evidence, however, in the past that these kinds of things do occur and have occurred and I think one of the primary responsibilities we need to look at now is exactly why these long-term fluctuations are occurring in the climate record.

This is a little bit different emphasis than, for instance, looking at next month's weather. We are talking about a much longer time scale. Let me just summarize here some of the important points.

First off, the drought in terms of an agricultural perspective in the Southeast was, indeed, the most severe that we have witnessed in the past century and its recurrence interval without climate change is in the order of a couple hundred years.

The hydrological drought which affects stream flows and lakes, which has resulted in some of the lowest stream flow in more than half a century, is unusually severe, but to date it is not unprecedented in terms of its duration, and in fact, is still ongoing.

We are not out of the woods yet, so to speak.

Finally, there is no evidence to indicate that the 1986 drought is a result of increasing carbon dioxide or other trace gases. Rather, it appears the most recent drought is part of one of a series of climate fluctuations that are typical of the climate record not only in this area, but throughout much of the United States and the globe.

That is all I have to say.

[The prepared statement of Mr. Karl follows:]

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Testimony of

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on

The 1986 Southeast Drought in Historical Perspective

for the

Subcommittee on Natural Resources, Agricultural Research, and Environment

Committee on Science and Technology

United States House of Representatives

Monday, September 29, 1986

I am pleased to be able to provide this subcommittee with a historical perspective of the 1986 drought in the Southeast. In order to facilitate the subsequent testimony it is important that we understand what is meant by the word "drought." The word itself often has different meanings to various groups depending upon their specific interests. Today, I will refer to two aspects of drought. The first aspect will pertain to the hydrological drought or the long-term water deficiency in deep soil profiles. This aspect of drought is important with respect to regional, municipal, and local water supplies used for domestic, commercial, and industrial processes. The hydrological drought usually requires at least several months of dry weather to develop. Likewise, it normally takes an extended period of wetness, months to years, before the hydrological drought ends; returning water levels in streams, lakes, and ground water to near normal.

The second aspect of drought that I will address pertains to a short-term moisture deficiency in shallow plant root zones or the so-called "agricultural drought." By definition, this occurs whenever the vegetation of an area is stressed due to an inadequate or below normal supply of moisture. This type of drought can develop rather suddenly compared to the hydrological drought. Sometimes just a few weeks without adequate moisture in the Southeast, depending on the timing during the growing season, can often lead to reduced crop yields and stress on vegetation.

It is important to understand that the hydrological drought may persist during several waxings and wanings of the agricultural drought. Likewise, the onset and termination of an agricultural drought can occur in the midst of a hydrological wet spell.

Two further clarifications are required. I will discuss the 1986 Southeast Drought from a climatological perspective. Note that for equal anomalies of dry weather separated in time, the human impact of these events may not necessarily be the same. Changes in water demand, i.e., increased usage for industrial, commercial, or domestic purposes, or changes in water supply and distribution, i.e., new reservoirs, loses in water supply lines, new water supply lines, etc., are not accounted for in a climatological perspective. Additionally, it must be recognized that drought is relative to some expected normal. For example, our natural environment and our local economies in the Southeast are based on a relatively ample supply of rainfall compared to drier portions of our nation such as the western Great Plains or the Southwest. Using this concept of drought, the departure from the expected moisture supply is "all important," rather than the absolute amount of precipitation, in order to compare and contrast the temporal and spatial characteristics of droughts.

The initiation and development of the 1986 drought.

During the fall of 1985, largely due to a very wet October and November, much of the Southeast United States was able to pull itself out of the hydrological drought that had developed over the

area during the past year. This included the Carolinas (NC and SC), the Virginias (VA and WV), Georgia (GA), parts of Alabama (AL), and Florida (FL), as well as the eastern half of Tennessee (TN). During the subsequent winter months, December 1985 through February 1986, a lack of Gulf Coast and East Coast winter storms resulted in the driest winter of the twentieth century in NC, the second driest in Mississippi (MS), Louisiana (LA), and TN, and the fifth, sixth, and seventh driest winters in SC, AL, and Kentucky (KY) respectively. As a result, by the end of winter a moderate hydrological drought had re-developed from LA northeast to southern VA. Conditions continued to deteriorate during the beginning of the growing season in the Southeast. March through May was the second driest spring of the twentieth century in NC, the third driest in TN and VA, the sixth driest in KY, and the eighth driest in SC. These conditions intensified the hydrological drought leading to a simultaneous occurrence of a severe agricultural drought in many of these states. Precipitation continued to be well below normal across AL, SC, NC, VA, and GA during the first two months of summer as the driest June of the twentieth century was recorded across the state of VA, and the seventh driest in NC, SC, and GA. Temperatures during these months were much above normal, increasing the demand for water. The warmest July of the twentieth century was recorded in the states of NC, SC, and GA while TN, VA, and AL had their sixth or seventh warmest July. Precipitation remained well below normal during July in all of these states with SC and GA having their third and fourth driest Julys. The dry and hot weather produced the most extreme agricultural drought of record in many of these areas. The hydrological drought continued to worsen through July when it reached its maximum areal extent. Streamflow across most of the southeast was less than 50% of normal during these months. During August and September cooler and wetter conditions abated the agricultural drought in most areas of the Southeast and improved, but did not end the hydrological drought.

The 1986 hydrological drought in historical perspective.

In order to make some quantitative inferences regarding the severity of the hydrological drought a model has been developed which produces an index of hydrologic drought severity. This index, the Palmer Hydrological Drought Index, identifies the month of drought initiation as well as termination. During each drought episode precipitation deficiencies can also be calculated in terms of accumulated precipitation deficits from normal. In order to put the current drought in perspective, we have used the model to evaluate the climatological data throughout the United States back to the turn of the century. This has been completed for nine of the most severely affected areas of the Southeast ---

1) North Central, GA,
2) Northeast, GA,
3) Central, GA,
4) Southern Mountains, NC,
5) Northern Mountains, NC,

6) Central Piedmont, NC,
7) Southern Piedmont, NC,
8) Northwest, SC, and
9) Eastern, TN.

Using a statistical model it is possible to estimate the unusualness of the recent hydrological drought. Using the actual index of the hydrological drought severity as a measure of its intensity the results indicate that on average, assuming no climate change, we can expect a hydrological drought as severe as the 1986 drought to recur about once in every 40 to 100 years for the areas outside of NC, and in excess of 100 years for the regions tested within NC. On the other hand, using the cumulative deficit of precipitation as a measure of drought severity the recurrence intervals for a hydrological drought as severe as the 1986 drought are between 20 and 60 years. The exact year varies with each region. Additionally, at least half of the streams in the area set new record low streamflows by the end of July. These streams had records dating back from 48 to 91 years.

By way of comparison, one of the most severe hydrological droughts in the United States occurred during the dust bowl days of the 1930s in West Central, Minnesota (MN). For that particular hydrological drought the recurrence interval is about once in every 200 to 400 years regardless how it is viewed.

We must recognize however, the final word may not have been spoken regarding the ongoing hydrological drought in the Southeast. Despite the improved situation in most of the Southeast in recent months the hydrological drought index indicates that the 1986 drought, in hydrological terms, is not yet history. Indeed, its duration has been relatively short compared to the longer droughts in the climate record i.e., the 5-year long drought in the mid 1950s and others that have persisted for a couple of years.

The 1986 agricultural drought in historical perspective.

In order to estimate the severity of the climate conditions with respect to the agricultural drought in the Southeast another index is used, the moisture anomaly index. This index is a measure of the short-term moisture deficiency. It is evaluated on a monthly basis and has no memory of past conditions except for the initial amount of moisture in the soil at the start of a month. For each month of the year the index integrates several climate dependent variables. This includes the expected initial amount of moisture stored in the soil at the start of a month, the expected amount of rainfall runoff and recharge to the soil given the initial condition, and the expected amount of moisture to be given up by the soil due to evaporation and plant transpiration. The moisture anomaly index, or the Z-index as it is commonly called, has been calculated for the United States back to the turn of the century. The mean value of this index through the beginning and middle portions of the growing season (March through

July) was calculated for the nine regions most severely affected by the hydrological drought. By comparing the magnitude of the most recent drought with previous agricultural droughts for the same time period (March through July) it is possible to estimate the recurrence interval of the agricultural drought for each region.

Through the use of another statistical model the results indicate that for the areas in Georgia, an agricultural drought as severe as the recent one would not be expected to recur on average more than once in 100 years. For the other regions the recurrence interval is even longer. The average recurrence interval for an agricultural drought as severe as the recent drought in Eastern TN, Northwest SC, and the Southern Mountains of NC is about once in every 200 years. For the Central and Southern Piedmont and Northern Mountainous areas of NC the recurrence interval of the March through July agricultural drought is on the order of once in every several hundred years. The agricultural drought in these areas was the worst since climatological observations became routinely available (Circa 1890) and is truly remarkable in its strength.

Is the recent drought related to the predicted climate changes from increased carbon dioxide and other greenhouse gases?

We currently have no evidence to indicate that the recent drought is a result of global increases of carbon dioxide and other greenhouse gases. Assuming continued improvement of the hydrological drought the recurrence interval for the recent hydrological drought is not sufficiently long to make it inconsistent with the twentieth century climate record. The agricultural drought during the growing season (March through July) was quite remarkable in its intensity for a few selected areas, but single growing season events, even moderately rare ones, do not necessarily imply a semi-permanent change to a new climate regime.

The climate must be viewed on larger time scales. In this regard the most unusual characteristic of the precipitation climatology in the Southeast during the recent century has been the anomalously wet and cool years of the late 1950s and the decades of the 1960s and 1970s. This wet period coincided to some extent with the greatest change in our national average precipitation since the dust bowl days of the 1930s. Since 1970 spring and autumn precipitation across the nation as a whole has increased by about 6% and 12% respectively, compared to the twentieth century average. This has lead to nearly a 5% increase in annual precipitation. By comparison, on an annual basis the decade of the 1930s in the United States had almost 6% less precipitation than the rest of the twentieth century; yet, areas such as West Central MN, which were so severely affected by that drought, are now coping with too much water as many lakes in the United States, the Great Lakes and the Great Salt Lake to name just a few, are at record high levels.

As more and more of the twentieth century climate records are compiled and processed the evidence seems to indicate that our climate is dynamic not static. Until we can adequately explain many of these decadal climate fluctuations it will be difficult to unequivocably relate ongoing climate anomalies such as the recent drought in the Southeast to increases in greenhouse gases.

Summary

1. The 1986 agricultural drought in the Southeast during the critical March through July period, was the most severe that we have witnessed in the past 90 years.

2. The hydrological drought, which resulted in the lowest observed streamflows in more than half a century, is unusually severe, but, to date, not unprecedented in terms of duration and has not ended.

3. There is no evidence that the 1986 drought in the Southeast is a result of increasing carbon dioxide or other trace gases. Rather, it appears that the most recent drought is part of another one of a series of climate fluctuations that are typical of the climate record of the United States throughout the twentieth century.

Mr. VALENTINE. Thank you very much, Mr. Karl.

Briefly, could you just describe your operation?

What is the National Climatic Center?

How many people are involved and what do you do? What technologies do you employ?

Mr. KARL. One of our primary purposes is to collect data throughout the globe and archive it for climatological information for weather forecasting purposes, for in all countless kinds of studies that are needed in terms of being able to withstand environmental conditions.

We have about 300 employees, of which I guess about 120 of them right now are being contracted out—this very week, in fact. So I guess we are down to about 200-some-odd employees which collect data, gather it, summarize it, provide enough information to adequately describe the climate of the United States.

Mr. VALENTINE. Thank you, sir.

Mr. Cobey, any questions for this witness?

Mr. COBEY. Just one. You say there is nothing man has done to bring about this type of drought or the severity of it?

Mr. KARL. I say there is no evidence to suggest that this particular drought would be a result of anything man has done.

Mr. COBEY. This is a very simple question, but we continue to impound more and more water around the world. Does that have any impact on rainfall?

Mr. KARL. Certainly it has an impact, but the question is whether that impact is so minimal as to not be detectable. We have a number of environmental kinds of studies that have been done.

We know, for instance, impoundment of water affects the duration and frequency of fog, but very, very few instances to show the impoundment of water has actually changed the amount of precipitation that has occurred.

You may find some very, very few pieces of information where you could find some cloud trails, cloud streaks from impoundments of water, but it is few and far between.

Mr. COBEY. That is all I have.

Mr. VALENTINE. Mr. Chairman.

Mr. SCHEUER. Yes; how long do you think it is going to be, Mr. Karl, before we are going to be able to predict this drought or droughts like these well in advance?

Mr. KARL. I think we are decades away from predicting a drought such as this, primarily because it is an unprecedented event in many respects and in terms of predicting unprecedented events, that is one of the most difficult things one can be asked to do.

So I think for droughts as this one, I think we are a ways away. We may not be so far away of giving 3, 6 months notice that conditions may be below normal.

For instance, we may expect less precipitation than normal but that does not imply scope or magnitude of current situation.

Mr. SCHEUER. You call this an unprecedented event. Are unprecedented events like this and the 1977, 1978 severe cold, are they becoming less unprecedented?

In other words, are they becoming more frequent, and if so, why?

Mr. KARL. One of the things that becomes apparent when you look at the climate record, depending on what quantities you look at, for example, if you look at wintertime temperature and precipitation, for instance, the 1977, 1978 events, you find in the United States as a whole there is strong evidence to suggest that the climate is becoming more variable. That is, wintertime conditions across the whole United States.

One thing to keep in mind, and what is even more unusual, is the lack of this high variability we experienced in the sixties, early part of the seventies, and later part of the fifties.

So we had gotten use to, so to speak, a 25-year period in one of these climate fluctuations we are talking about, of unusually good weather.

So that puts the more recent change to more variable conditions in better perspective, that perhaps we weren't within our lifetime—we hadn't witnessed many of these unusual events we are now experiencing.

Mr. SCHEUER. Do droughts like this, massive acts, as you say, almost unprecedented droughts, do they have a tendency to reappear the following year?

In other words, is this a multiyear cyclical event that we can look forward to?

Mr. KARL. Yes; there have been a number of studies looking at cycles of drought and to date none of the studies indicate that there is any reasonable way of being able to predict the drought saying next year or the following year is more likely to have a drought.

Mr. SCHEUER. On a scale of 1 to 10, what would the predictability of another year's drought be? Would it be more than five or less than five?

Mr. KARL. For next year?

Mr. SCHEUER. For next year.

This is the severest drought we have had in the century, so you would think the chances for another year like this would be 1 in 100. Are they much more than that and if they are, is there anything we can do to ameliorate the possible devastating effects of this drought that we have a statistically higher than likely possibility that we have of suffering another one next year?

Mr. KARL. I would point out that since, if you look at the climate record, you find that we apparently in the Southeast now are in a different climate regime than we were in the fifties and sixties, that is, conditions are drier.

But I would also point out since we don't know why we are in this regime, conditions could change rather dramatically and quite fast. So, given the fact that we remain in the current regime, then the likelihood of a kind of a drought that we just had this past year would be higher than it might be otherwise.

But since we don't know exactly why we are in the climate regime we are now, things could just as rapidly change back to some new state and the problem is solved.

It is a basic problem in our not understanding the climate system in terms of being able to predict the drought.

Mr. SCHEUER. I thank the witness for his excellent testimony.

Mr. VALENTINE. Mr. Karl, before we dismiss you, let me say one more thing. You are not saying that we are in technology and our ability to look into the future and to predict a drought, you are not saying the best thing we have is the Farmers Almanac, are you? Never mind.

Mr. KARL. No. I am not saying the Farmers Almanac is the best thing. I am saying what we need to do is take a little bit closer look at these climate fluctuations and try to understand them with a little more detail.

Mr. SCHEUER. If it isn't the Farmers Almanac, is it the groundhog?

Mr. VALENTINE. Do you ever take a peek at one of these almanacs?

Thank you very much for coming. Your testimony has been very helpful.

Thank you.

Mr. KARL. Thank you, sir.

Mr. VALENTINE. The next panel is Gregory B. Fishel, WRAL, Raleigh; Chris Thompson, WPTF, Raleigh; Gregory Johnson and Katharine Perry from North Carolina State University.

STATEMENTS OF GREGORY B. FISHEL, WRAL, RALEIGH; GREGORY JOHNSON AND KATHARINE PERRY FROM NORTH CAROLINA STATE UNIVERSITY

Mr. FISHEL. As everybody has stated, I would like to thank the committee for the opportunity to speak and, I think, also to add to that a thanks not only for the opportunity to speak, but for the opportunity to learn, particularly from the first panel this morning.

Certainly in my business you can stand up and say that you can try to identify with what someone is going through, but until you have experienced that first hand or talked to someone who has, I don't think it affords itself a true meaning.

Here this morning we are talking about a drought which has already been discussed in an agricultural sense the worst of the century, in a hydrological sense, the worst of the half century.

Every time a catastrophe of this nature occurs two questions arise: No. 1, could we have dealt with the situation any more effectively making use of available information and technology; and two, what positive changes can be made to help avert a rerun of the summer of 1986.

This morning, I will discuss data which is currently available, both in terms of drought assessment, as well as forecasts of the future weather, then speculate as to how all this might be improved in subsequent years.

The Climate Analysis Center, contained within the National Meteorological Center in Washington, DC, disseminates drought information on a weekly basis in two forms. They are the Crop Moisture Index and the Palmer Index.

The Crop Moisture Index relates more to agriculture than anything else. It is used to estimate the amount of soil moisture available in a 5-foot profile, and then compares that with the need of warm season crops. The index responds rapidly to changes in soil

moisture, and does not provide an accurate assessment of the current situation beyond about 4 weeks.

By contrast, the Palmer Index picks out areas that are experiencing long-term drought. This index changes little from week to week and reflects rainfall deficiencies that have arisen over several months or even years. Variables used to compute these indices include temperature, rainfall, evapotranspiration, recharge, and runoff.

And where does this data come from? Well, there are 344 climatic divisions within the United States, and North Carolina has eight. They are the northern and southern mountains, the northern, central and southern Piedmont, and the northern, central, and southern coastal plain. These divisions cover a lot of territory and the computed index values do not reflect local variations. However, they do give one a feel as to how different parts of the State are faring.

The Palmer Index values have continued to run very low in the central part of the State in recent weeks, but because this is such a large area, it is being skewed by the fact that conditions in Greensboro and Charlotte are much worse than they are in the eastern Piedmont and the Sand Hills. So, to this point, we have talked about information that is available and how bad off we are.

Beyond that, the question is, could we have foreseen this to any degree, and do we have any capability of forecasting how this current situation will change in the coming weeks and months?

There are several products available at present that do indeed help us to at least make an educated guess as to future drought severities. First, the Climate Analysis Center also makes available a Projected Palmer Index. This projection makes use of current drought information, and combines it with climatic data from the past 55 years to give you a probability as to how the index will change over the next 3 months.

Although this is helpful, it is more statistical than anything else and would not be able to foresee a change in the current weather regime. Also available is a rainfall amount needed to end the long-term drought in a given division. But this is an instantaneous value.

For instance, if 15 inches of rain is needed to end the drought, it means that 15 inches would have to fall that week, to be followed by normal rainfall thereafter. It does not mean 15 inches over the next 6 months.

With regard to forecasting future weather events, computer models can be of some help. Among many numerical models run by the National Meteorological Center is the MRF or medium range forecast model. Once a day, this is run out to 240 hours or 10 days.

Three times per week, a 6-to-10-day forecast is issued based on this model. It makes large scale predictions regarding temperature and precipitation anomalies.

But, again, these outlooks are not perfect. We need only look back to July and August to prove this fact. North Carolina started the summer of 1986 extremely dry.

Then suddenly a complete reversal to one of the wettest months in history for a few areas, including the Triangle. No computer model indicated such a massive change. And even if they were

highly accurate, they do not address local variations within a given region of the country.

Thirty- and ninety-day outlooks are also available, but here, the reliability is even less. These outlooks are based on statistical information, looking at how past seasons with similar beginnings turned out. They also consider anomalies in sea surface temperatures across the world and how this might affect the large scale flow patterns. The reliability here is only slightly better than flipping a coin at the present time.

As to what can be done in the future, I do not have any terribly good or important news. It is important to note that the Federal Government does make drought information available. Perhaps we should consider exactly who has access to this information and how we can get it to the individuals that really need it.

The media is certainly in a position to help out in this area. In terms of forecasting changes in the drought situation, patience is the word of the hour. Numerical modeling will undoubtedly continue to improve in coming years, and as a result, our ability to forecast significant changes in temperature and rainfall will also improve.

But remember, for the individual farmer, all he or she cares about is his or her property. And nobody at present has the tools to forecast the weather accurately on that small of a scale. In order to make accurate and small scale forecasts, one needs an abundance of observations, not only in time but also space. The cost of such an observing network is enormous and more than likely beyond the scope of current budgets.

[The prepared statement of Mr. Fishel follows:]

DATE: SEPTEMBER 29, 1986

TESTIMONY BY GREG FISHEL

CONGRESSIONAL SUBCOMMITTEE
ON NATURAL RESOURCES, AGRICULTURAL
AND ENVIRONMENT

CONGRESSIONAL HEARING ON THE DROUGHT OF 1986

Today, all of us are gathered here to discuss a drought, which has been described as one of the worst, if not the worst of the century. Every time a catastrophe of this nature occurs, two questions arise: 1.) Could we have dealt with the situation any more effectively making use on available information and technology. 2.) What positive changes can be made to help avert a rerun of the Summer of 86. This morning, I will discuss data which is currently available, both in terms of drought assessment, as well as forecasts of the future weather. Then finally, I would like to speculate as to how all of this could be improved in subsequent years.

The Climate Analysis Center, contained within the National Meteorological center in Washington, D. C., disseminates drought information on a weekly basis in two forms. They are the Crop Moisture Index and the Palmer Index. The Crop Moisture Index relates more to agriculture than anything else. It is used to estimate the amount of soil moisture available in a five foot profile, and then compares that with the need of warm season crops. The index responds rapidly to changes in soil moisture, and does not provide an accurate assessment of the current situation beyond about four weeks. By contrast, the Palmer Index picks out areas that are experiencing long term drought. This index changes little from week to week and reflects rainfall deficiencies that have arisen over several months or even years. Variables used to compute these indices include temperature, rainfall, evapotranspiration, recharge and runoff. And where does this date come from? Well, there are 344 climatic divisions within the United States, and North Carolina has 8. They are the Northern and Southern Mountains, the Northern, Central and Southern Piedmont, and the Northern, Central and Southern Coastal Plain. These divisions cover a lot of real estate and the computed index values do not reflect local variations. However, they do give one a feel as to how different parts of the state are faring.

To this point, your reaction may be, fine. Now we know beyond the shadow of a doubt that we are in trouble. The question is, could we have foreseen this to any degree, and do we have any capability of forecasting how this current situation will change in the coming weeks and months? There are several products available at present that do indeed help us to at least make an educated guess as to future drought severities. First, the Climate Analysis Center also makes available a Projected Palmer Index. This projection makes use of current drought information, and combines it with climatic data from the past fifty-five years to give you a probability as to how the index will change over the next three months. Although this is helpful, it is more statisitical than anything else and would not be able to foresee a change in the current weather regime. Also available is a rainfall amount needed to end the long term drought in a given division. But this is an instantaneous value. For instance, if 15 inches of rain is needed to end the drought, it means that 15 inches would have to fall that week, to be followed by normal rainfall thereafter. It does not mean 15 inches over the next six months.

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Mr. VALENTINE. Thank you, sir.

Ms. Perry, or whichever one would like to be forward.

Ms. PERRY. Mr. Johnson would like to begin.

Mr. VALENTINE. Fine.

Mr. JOHNSON. It is a pleasure to be here. We thank you for the opportunity to come and speak here this morning.

Dr. Perry and I would like to briefly tell you a little bit about our program. We are involved with the North Carolina Agricultural Extension Weather Program, which is located in the horticultural science department at North Carolina State University in Raleigh.

Our program began approximately 6 years ago after a concerted effort by a number of individuals within this State, as well as a number of individuals, to fund a weather program designed specifically to look at how the weather would be impacting the agricultural community.

Estimates are that approximately 3 percent of our agricultural base is lost each year due to the weather from either drought, hail, freezes, or whatever. This is approximately $120 million.

As we have already heard this morning, over $330 million is the estimate simply from the drought this year and this does not include, of course, the other losses which have occurred. Our program began in 1980 and is now State and federally funded.

We issue two agricultural weather advisories Tuesday through Saturday and then one each on Monday and Friday. These advisories contain information, including livestock and poultry heat stress or cold stress forecasts, forecast of drying conditions and evaporation rates, wind speeds for spraying, pest and disease control recommendations and forecasts, frost and freeze advisories and warnings, soil temperature reports and forecasts for planting and fumigation and then as well as routine forecasts for temperatures and precipitation probabilities.

Let me state that we base our advisories upon National Weather Service zone forecasts and we feel very fortunate to have a real good working relationship with the National Weather Service forecasters at the Raleigh-Durham Airport and we do base our forecasts upon their products. Our advisories are disseminated through several channels. These include the National Weather Service weather wire, which goes to a number of radio and TV stations and groups. AP and UPI news wires also distribute our products daily as does the National Weather Service Radio Network.

There are nine of those stations in North Carolina plus the Norfolk, VA, station serves the northeastern corner of the State, a large peanut producing area. And the North Carolina Department of Agriculture Market News Line, which is a service through the UNC public television stations, also now deliver our product along with Market News Daily.

Let me just say that our program is also involved in research, predominantly looking at how bioweather relationships are involved and also in computerization. We all know that as computers become more common as a farm tool, it will be increasingly important to integrate these into operational farm management systems.

Farmers also need to be educated as to what weather information is available, how they can receive it and how they can use it

and utilize it into their operations. This is certainly a mission of our program and one we feel strongly about. We educate through farm meetings and through extension service meetings. We are involved in these throughout the year.

Well, turning our attention specifically to the drought this year, which as we have heard has been among the worst in history, first of all, routinely our advisories dealt with the drought and how farmers could cope with it, as well as the latest forecasts and long-range outlooks as to how the drought situation might progress.

Beginning in April we recommended such things as minimum tillage practices and that farmers might want to consider planting drought-resistant crops. Let me just say a lot of our recommendations are based on our communication with extension specialists and other researchers on campus at North Carolina State.

So this isn't information that we simply dream up, but it is information by the specialists in that we rely upon their expertise quite heavily.

In May and June we also continued these recommendations plus we began our routine evapotranspiration and drying conditions forecast. We feel that this will aid the grower in helping him in his irrigation scheduling; for instance, to know evapotranspiration over the coming few weeks will be approximately 2 inches.

If he knows that information, he will know how he can plan. Then July, early August as the drought really began to become serious, and, in fact, extreme in most parts of the State, we took upon ourselves to include in the advisories information that was coming from specialists such as recommendations to consider culling livestock herds to prepare for what would certainly be a shortage of feed during the fall—and of course, we saw that with emergency hay deliveries which came into North Carolina—irrigating only a portion of their crop so at least they would have some type of a harvestable crop. Rather than trying to, say, irrigate all 300 acres, they had just to limit it.

Then, in addition to regular advisory issuance, we were involved in several other dissemination methods. One of these was the extension service sponsored drought seminars in Raleigh, Greensboro, and Stateville, and we were a part of that by presenting information about the drought as well as along with other specialists.

There were two drought-related television shows on public TV. This was a call-in show across all of North Carolina where farmers and other persons could call in. We responded to their call-in questions.

We appeared on numerous television shows and radio programs to get the word out, including the "CBS Morning News." Newspaper and radio interviews were common place, took a good part of our day and just through the normal extension service outlets, which we feel fortunate to be within the extension service, because they have excellent communication, getting the word out to local radio stations, newspapers, through their releases, radio tapes and such.

Well, in summary, we feel like the drought continues to go on. We want to mention that September has been one of the driest Septembers in many parts, especially eastern North Carolina and that we should not be thinking the drought is by any means over

and certainly looking at indications the next few weeks we don't see any change.

There has been discussion here this morning about long range weather prediction, its limitations. You heard Mr. Karl speak to that and about how the farmer would react to a long-range prediction, whether even if it was reliable weather forecast, whether they would believe it. But we feel strongly that Federal funding for long-range prediction and seasonal forecasting should continue, that certainly this should not be a reason for us to curtail our research into this area because we can see great benefit from it and even a seasonal forecast, say, early in this spring, if a farmer had known even some type of indication that it would have been even moderately dry, there are certainly some things that they can do, increasing their water storage capability, planting different types of crops, cutting down on tillage and such.

So that is one recommendation that we would make. Now, I will turn it over to Dr. Perry, who will conclude our presentation.

Mr. VALENTINE. Dr. Perry, we will be glad to hear from you at this time.

Dr. PERRY. I am happy to present what we have today. I would like to underscore some of the things Greg has mentioned, particularly the educational aspect of our program.

I think the farmer that presented his ideas earlier might be a good example in that I think some of these people are not even aware of some of the things they could do if this information was available to them.

His particular operation might not be as lending to good use of long-range forecasts for the season, but many, certainly row crops, vegetable crops and these kinds of things would. The choice of varieties whether or not irrigation is economical, those are long-term decisions that this kind of information can provide. On a larger spectrum, agriculture weather services are in great jeopardy in this country. Your committee has worked apparently very hard to reinstate the funding each year, but the fact that it goes on the cutting block each year is almost as detrimental to programs as not getting the money at all.

As retirements and positions are left, who wants to come into a position that might only be there a year? Recruiting good people in this area is difficult.

This goes all the way down the line to students preparing for this area.

Mr. SCHEUER. Dr. Perry, let me just interject there, it is true that the administration for each of the last 5 years has tried to cut this program, but it is also true that the Congress, as the closest institution representing the people of North Carolina and other States, has intervened and has prevented that.

So the funding has not fallen. You know, next year, if the three of us are reelected, we are going to take the oath of office next year in the 100th Congress. We will be very proud of that.

That means 200 consecutive years of unbroken service of the Congress of the United States to these communities. Now, the Congress is absolutely convinced of the value of the weather services and I think you ought to have more confidence in our toughness and our fighting ability.

We have defended this program for the last 5 years against the onslaughts from the current administration and I think you ought to have more confidence that we will continue to do that.

OK.

Dr. PERRY. I would like to, yes.

Mr. SCHEUER. I want you to. All three of us want you to, don't we, Bill?

Dr. PERRY. I think the farm bill has language that gives the opportunity to make sure of this. It has designated that the USDA and NOAA are responsible for providing agricultural weather services and also——

Mr. SCHEUER. We have protected the rear end, butt, and flanks of this program for many, many years. This isn't a personal thing. It is not just Bill, or me, or Tim. The Congress itself will not permit this program to be wiped out.

This is not a political thing. It is a bipartisan, bicameral consensus. It is between the House and the Senate and it is between the Democrats and the Republicans.

We are not going to let any administration wipe out or significantly reduce support for these programs because we think they are tremendously helpful to communities and to States. When you have finished your positive testimony, your excellent testimony, I am going to ask you whether these services have been helpful to you and what they mean to the average North Carolina farmer.

I am sorry to have intruded, but you indicated such lack of faith in the future of funding of this program I had to intervene to tell you that the three of us are absolutely as one.

Frankly, we go the political spectrum of this Congress, you see. So have confidence.

Dr. PERRY. That sounds great, but that is not what filters down. So if that exists, then that needs to be communicated because what comes down to my level, which is the bottom, is that every year this is zero budgeted. I have worked on national committees in this area and it is not a very secure feeling.

So somehow you all need to communicate to those of us out there that this is true.

Mr. SCHEUER. I am very proud and delighted that Bill and Tim have afforded me the invitation to come down here and have an official committee hearing here. You know, the purpose of these committee hearings is to educate the Congress on what the problems are, to give us some kind of hands-on feeling as to what the problems are in the grassroots.

But it is a two-way process, too, because we can educate the community. Education and understanding is a two-way process. I just hope that there is some way that I can convince you that the three of us really span a political spectrum from AA to ZZ, from Aardvark to Zimbabwe.

We are determined to continue this service. Now, period. We have the muscle to do it and we have proven that in the last 5 years.

Please, all of you out there, have confidence that the Congress is not going to permit this service to be tampered with or played with, no political games with this service. We think it is too impor-

tant to the citizenry and to the extent that this local hearing is a two-way learning process, we want to get this word out.

We have learned a lot from you this morning. If there is one thing that I hope you learn from us, it is the three of us, representing the Congress, stand as one behind this service and you really should not fear that it is going to be messed around with.

Mr. VALENTINE. I want to associate myself with the chairman's remarks and say on the strength of that would you leave me an application for employment with you?

Mr. SCHEUER. I am convinced Congressman Valentine will be ineligible for your service because of the rules against double dipping. He has already got a job. He is going to continue in that job.

Mr. VALENTINE. At least you didn't say because of old age.

Dr. PERRY. Well, I feel better about it already, but even the system that is in place now—we in North Carolina are very fortunate. Our State, with Federal funding, has seen fit to provide this program. But it is not a nationwide system. It is different in each State and that probably is good in that each State's agricultural needs are different.

But I don't think every farmer in this country has an agricultural weather service equal to what some other farmer has. It is different.

There are frost programs that have been held onto in other areas. In North Carolina we didn't have an agricultural weather service until this program was initiated.

Mr. SCHEUER. Now you do have. Now tell us what it means to the farmers of North Carolina.

What services does it provide for them?

Dr. PERRY. I think Greg outlined those in that our main service is the advisory to our growers. That is day-to-day weather management in their day-to-day operations. As our forecasting abilities increase, that information will be better.

But what is happening in the agricultural community, as I see it, is very sophisticated computer models are being initiated and made operational and the farmers that survive the current crisis of economic and all the other stresses they are going through, will develop into what I think are very astute businessmen.

They will have to know the economics of each move they make. These kind of models will help them determine those things so that in a year like this, hopefully, those that had made these kinds of decisions ahead of time would have seen that in so many years out of a hundred it would be likely that they need irrigation and is that economical and these kinds of things.

Hand in hand with the better information will be also better dissemination techniques, satellites, the whole ball of wax, will be able to be applied to this area. It will just continue to be more sophisticated and more technologically intensive.

Hopefully, as our program can develop and expand, we can provide that information.

[The prepared statement of Mr. Johnson and Dr. Perry follows:]

DISSEMINATION OF AGRICULTURAL WEATHER INFORMATION

Katharine B. Perry and Gregory L. Johnson
Department of Horticultural Science, North Carolina State University
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Agriculture is a 4 billion dollar industry in North Carolina. Weather has been estimated to cause an average yearly loss of 3% or 120 million dollars. In response to this, the North Carolina Agricultural Weather Program was implemented in early 1980 to respond to the state's need for agriculturally pertinent weather information. Two agricultural meteorologists comprise the program which is supported by state and federal funds through the NC Agricultural Extension Service and Agricultural Research Service. Twice daily weather advisories are produced which are interpretations of National Weather Service (NWS) forecast products and describe how the forecasted weather will impact agricultural industries. The advisories routinely include heat/cold stress forecasts for livestock and poultry production, frost/freeze warnings, soil temperatures for planting and fumigation decisions, precipitation forecasts for pesticide and fertilizer applications and irrigation scheduling, wind speed and direction for spray operations and temperatures and humidities for disease management. The advisories are disseminated through the NWS over the NC Weather Wire. From this wire service numerous commercial radio and TV stations and all nine NOAA weather radio stations air the advisories. The NC Department of Agriculture receives the advisories via microcomputer communication and subsequently broadcasts them on the Market NewsLine.

The Agricultural Weather Program is further charged with identifying, developing and implementing programs that utilize bio-weather relationships based on current weather information. As computers become a more common on-farm tool, it will become increasingly important to integrate these programs into operational farm management systems.

Farmers need to be educated as to what weather information is available, how they can receive it and how they can use it to minimize their weather related losses. The Agricultural Weather Program is further charged with this educational responsibility.

The North Carolina Agricultural Extension Weather Office responded to the drought of 1986 in many ways. Numerous media appearances plus regular channels of dissemination were utilized to deliver the most complete and timely agricultural weather information possible to farmers throughout the state.

The effort began in the early spring when the drought was just beginning to be noticed. Precipitation deficits were noted every month starting in December of 1985 and by early April topsoil moisture was already too short in many areas to allow good seed germination and growth of early crops. It was at this time that advisories recommended minimum tillage practices and planting more drought-resistant varieties. As the drought worsened through May and June, advisories continued to include specific recommendations about planting and cultivation and began to issue evapotranspiration (ET) and drying condition forecasts. This information could then be used by growers to effectively schedule irrigation for the upcoming three days. Forecast data needed to generate this information were obtained from National Weather Service forecast model output statistics. These data then served as input to computer programs which generate forecasts of ET and drying conditions for the next three days. Long range outlooks (6 to 10 days, 30 days and 90 days) were also included in advisories.

(Two Slides)

At the height of the drought in July and early August advisories continued to feature the information mentioned above plus specific measures to cope with the drought. These included possibilities such as culling livestock hands and irrigating only a small portion of the total acreage to insure at least some harvestable crop.

The N. C. Agricultural Extension Service sponsored drought seminars aimed at municipal water managers and agricultural officials in Raleigh, Greensboro and Statesville on August 18, 19, and 20. An agricultural meteorologist presented relevant information regarding the severity of the drought and ways of dealing with its effect. Drought information was also disseminated in frequent media appearances, including many newspaper articles and radio station interviews. A special Drought Impact TV show on UNC-Public TV throughout North Carolina featured Extension Specialists from many disciplines, including agricultural weather. This was a call-in show and many questions were answered by farmers across the state about how to handle the crisis caused by the lack of rain. Other TV appearances included the CBS-TV Morning News (national) and several TV news shows in Raleigh and Charlotte.

There is little doubt that the drought in 1986 was (and is!) as bad as any previous period in history across the Piedmont and Mountains of North Carolina. Drought information, including forecasts and strategies for dealing with its effects on the farm, were a focus of advisories issued by the N. C. Agricultural Weather Program. To further improve agricultural weather advisories the following actions are recommended:

1. Increase funding for seasonal and long-range weather prediction. There are some specific steps farmers and producers could have taken as early as the fall of '85 if some indication about how bad the drought would become had been available. Such information is simply not available now.

2. The technological base for agricultural weather forecasting, dissemination, and usage is changing. These components now include satellite data, new communication via satellite, and new forecasting information from both a broad and now casting perspective. The use of microprocessors and microcomputers is changing the entire area of verification and real time weather data acquisition. Better relationships between weather and biological systems are evolving which can provide more quantitative agricultural advisories. Therefore, real time weather information can now be acquired and coupled with new dissemination methods. There needs to be a revolution in how this area is approached. Private and public roles must be re-examined and put in perspective to insure this valuable agricultural tool is available to American farmers. In the 1985 Food Security Act the U.S.D.A. and U.S.D.C. are charged with this responsibility. All efforts should be made to insure this law is enforced.

With continued and increasing support agricultural weather services for North Carolina will continue to develop and meet the needs of its agricultural industry as it becomes more sophisticated and technologically intensive. However, other states are not so fortunate.

A shift in federal government, state and private industry roles is taking place. The relationship between private, state and federal entities involved in weather activities must be clarified to facilitate more efficient use of limited financial resources. Without this cooperation, agriculture stands to lose a needed service due to funding instability and general program disorganization.

Mr. SCHEUER. Congressman Cobey.

Mr. COBEY. Thank you, Mr. Chairman.

What percentage of the farm community do you think you are reaching already with your program, so they can make these kinds of decisions based on your advisories?

Mr. JOHNSON. We did a survey about 3 years ago now of the broadcasters in the State and found that over 40 percent of the broadcasting stations in the State used our advisory at least once a day, in many cases much more than that, virtually covering every county in North Carolina. If you add to that the coverage of weather radio and now the Market News Line, virtually every farmer in the State has access to our advisory.

We feel just from meetings we have been to that probably say 50 percent use our advisory or at least hear it once a day and we are pleased with that progress just in 5 years.

Mr. COBEY. You feel like they are really making decisions based on those advisories and is this percentage significantly up over the past few years?

Mr. JOHNSON. Of course, we just started in 1980, and I think it takes a while to build confidence. But we have heard several stories, more than just several, of people who use our advisory on a daily basis in their planning operations. We don't have complete numbers.

Let me just give you one example. You asked about how the farmers were using the products in our State. One example is the peanut growers have been constantly, over the years, had a problem with leaf spot, a disease that attacks the crop. Specialists within the plant pathology department, extension service at North Carolina State, have developed a program which we are involved in of forecasting for leaf spot based upon the weather, because the documentation exists that you can predict when this disease will occur based simply upon temperatures and humidity.

We now have some weather monitoring stations within the peanut growing area of the State, and based upon these and each county, a grower can call the county extension office and hopefully by computer will be able to access this in the future and actually get a recommendation of spray fields or don't spray in a dry year such as we have had. Whereas a grower who is using a regular spray schedule, say, spray every 7 to 10 days would have sprayed 8 or 10 times. Using this type of advisory information he sprayed only three times, saving five sprays over several hundred acres, that is, many thousands of acres and had just as good a crop.

So that is just one example of how the weather is so tied to what is going on in the farm. Farmers know that and now we are beginning to see the documentation of that.

Mr. COBEY. I wanted to associate myself with the remarks of the distinguished chairman from New York. Any Administration proposes, but we dispose with it. There are a lot of political games played in Washington and, Mr. Chairman, you should know—and you probably already know—this is probably the best extension service in the Nation right here in North Carolina, run out of North Carolina State University.

When that budget came forward this year, with I believe it was a 60-percent cut, I took a very active part in making sure that that

funding was restored. So this is a bipartisan thing and there are a lot of games played up there, but ultimately we in the Congress hold the cards as to what is going to happen.

Mr. SCHEUER. That is absolutely true, Congressman. You did play a significant role there. Sometimes I think when the Administration comes up with some of these more absurd suggestions for cutting the funding and then the suggestion for commercializing the weather service, they really do it as part of their plan to produce more bipartisan cooperation in the Congress because every time they do it they have an explosion of bipartisan cooperation between the House and the Senate, the Democrats and Republicans, and Congressmen who may have been calling each other all kinds of nasty names are suddenly cooing at each other and embracing each other.

So I think the Administration really has this ulterior purpose of inducing more bipartisan participation in the Congress. I think that is also their game plan behind these occasional suggestions at commercializing the weather service.

Now, we had a hearing on the proposal to commercialize the weather service in Florida. We invited all those citrus growers in there. Very conservative Republicans, and of course, they exploded in anger at this suggestion and, there again, I was invited down there again to have this hearing by a Republican Congressman, Congressman Tom Lewis. Here you had again this situation of Republican and Democrat Congressman billing and cooing at each other and arch conservative businessmen joining with the Congress and saying this is a Federal service that made a lot of sense.

So I will give the Administration credit. Whether this is their intention or not, it certainly does produce a terrific, bipartisan consensus and renewed collegiality and sense of common purpose, doesn't it, Congressman?

Mr. COBEY. Yes. If you would yield——

Mr. SCHEUER. Of course.

Mr. COBEY. I wish these games were not played because I know it does really impact you who are in the field. Even if it produces bipartisan participation and cooing at each other within the Congress, I wish it was not played because it does cause so much concern out in the field.

I don't think that should be done. I would like to follow up on one thing with Mr. Fishel here. It seems that in recent years that the weather has become big news.

I don't ever remember it being big news before. We have all these warnings of hurricanes and tornados, and following up on Mr. Karl's testimony—I would like to get your response—are we seeing more severe weather?

How much of this is the fact that television wants more viewers and, therefore, they like to have dramatic news to report because we are always waiting for the 6 or 11 o'clock news to find out what is going on with the storm or how much is it just truly a change in the weather patterns that we are seeing more severe weather?

Mr. FISHEL. It should not theoretically have anything to do with viewership whatsoever. Whenever I express an opinion like that I have always been accused by station management of being too

idealistic and eventually I will grow up and learn and if I get too much older I guess I will never learn.

But I think the testimony has already been given that the variability in weather events in recent years has indeed increased. We have had more extremes in recent years. I think Boston broke their 24-hour snowfall record twice within a month back in 1978.

We see what is going on down here this year. Again, I think all of us are a little bit assuming when we think about the fact that we are judging climatic records with regard to a human lifetime or perhaps back into the 1800's when we started writing things down.

No matter what theory of creation you believe, we have been here for a heck of a lot longer than that. There is an awful lot of weather history which is not documented as well as what we have seen in the last 100 years, so, therefore, if we say this is an unprecedented event, I think that has to be qualified.

It is unprecedented with regard to one human lifetime, but it certainly may not be unprecedented with all the occurrences of weather that date back 3 or 4 billion years and we simply are not able to make statements like that.

With regard to radio and television station roles, you know, you get into this debate when a whole bunch of warnings are out, are you going to cut into the soap opera, are you going to cut into the evening news. We got a tremendously sarcastic letter, this lady must have gotten a Ph.D. in sarcasm, stating the only reason we cut into the CBS Evening News with a warning was so Dave Eichorn could publicize himself and become better known to the public.

Mr. SCHEUER. Excuse me. Who is Dave Eichorn?

Mr. FISHEL. He is one of the meteorologists on our staff that does one of the shows. That should not be a principle. The whole purpose of radio and television as defined by the FCC is to provide information to the public.

Warnings to the public should supersede any responsibility that the television station has. The more we get away from these rules and regulations as to whether or not agricultural weather makes good television, we cut back the amount of time that we provide farm information on the noon show to a very minimal amount, about 1½ minutes, because it does not make as good television as perhaps putting on the pet of the week or something like that.

Well, I think we know in North Carolina it is a tremendously important thing, agriculture is, from an economic standpoint and an emotional standpoint, and we need to stop worrying so darn much about good television and start worrying about how we serve the public.

Mr. SCHEUER. What would your reaction be to suggestions to commercialize this service and not provide it without charge but for the commercial contractor who is developing the information to charge the television stations, the newspapers, the growers and so forth, for a fee, for a service rendered?

Mr. FISHEL. The only comment I can make about that is that with regard to public forecasts as disseminated by the National Weather Service, the private sector is not theoretically employed to compete with the National Weather Service, although there are certain leaders in the private sector that will tell you otherwise.

Mr. SCHEUER. The theory of this Administration is the Weather Service should not be in the business of disseminating weather information. They maybe should be in the business of gathering it, but then they should let it out on a competitive basis and let the private sector firms distribute this service on a fee for service basis so that they would charge television stations, charge radio stations, charge newspapers, charge individual farmers and farm organizations on a fee for service basis.

In other words, getting the weather news would be a cost of doing business for the radio and television stations and for the newspapers and for individual farmers.

Mr. FISHEL. I can't say I really agree with that. It seems weather information is at the very heart of basic information that should be available to the public.

Now, the private sector can certainly supplement that, and if you need a more detailed service or a more specific service, then I think you do have the right to charge money for that for the people that have that need.

But for the general public to have to pay money to access basic weather information by a government that has a tremendous system to do just that, to forecast it, that does not make any sense to me.

Mr. SCHEUER. Would Mr. Johnson and Dr. Perry have a reaction to this conviction by the Administration that we ought to commercialize the Weather Service?

Mr. JOHNSON. I think the system is in place. I think the mandate is there for the Weather Service to provide warnings and that they have that charge and the staff that they have is excellent and the facilities they have. I think it is ridiculous for them not to be involved in disseminating basic zone weather information, forecasts and such as they do now.

They do an excellent job and I would like to just reiterate the fine working relationship that we have with them here. We simply couldn't do our job without them.

I think this is the kind of cooperation that I would like to see nationwide where we work within the extension service, we have the dissemination means there, the access to the agricultural community, but then we rely on the Weather Service for their expertise.

It is working very well here, we feel.

Mr. SCHEUER. Dr. Perry?

Ms. PERRY. I feel in the agricultural arena there is actually room for both. I think a service like ours that is a statewide information service is needed, but there is always going to be this need Greg alluded to right down there on the farm.

If some of these larger, more lucrative operations can afford a private consulting firm to provide that extra information, they think would increase their profits, that is fine. But I think the smaller growers and those in the industry that can't afford to hire someone privately should have some information available to them, too.

Mr. SCHEUER. Thank you.

Mr. VALENTINE. Mr. Fishel, let me ask you a couple of questions.

We talked about the difficulties which we have in long term climate predictions and predictability, that sort of thing. Our subcommittee is involved in funding state of the art weather forecasting technology that will be greatly advanced over what we have now and involves the use of satellites and that kind of thing.

Do you think that these new technologies will help any?

Do you think we will be any better off? Or are we up against something we can't look down the road 10 years?

Mr. FISHEL. If I can be philosophical for 1 minute, one of the reasons I like this field is that God made it sufficiently complicated so we will never figure it out entirely. That means there is always a challenge down the road.

Mr. VALENTINE. You don't mind if I use that sometime, do you? We go around stealing things like that. I just acquired that one.

Mr. FISHEL. I think He also gave us a mind to make use of and try to learn things. But just in the last 5 or 10 years there is now satellite capability where we can look at moisture contents on pictures without any clouds having actually condensed and this is being used widely in the middle part of the country especially to find where thunderstorms and tornados may form at certain times before clouds actually form.

So the whole process of remote sensing I think at one time we used to think we were going to have to put an observer on every city block to be able to get a real good density of data and now with the promises of remote sensing and how they are improving, it appears we may be able to not go this route. But it seems the improvement even in the short time I have been in the business has been phenomenal and I have nothing but great amounts of hope as to how that technology will be used in the future.

But, again, we are talking about forecasting a fluid that covers an entire globe and trying to forecast how that fluid will change on the scale of a farm and that is a mighty, mighty tough order based on the technology we have right now.

Mr. VALENTINE. Thank you all very much for being with us.

The next panel will address the general area of policy alternatives. Bill Hooke, Environmental Research Laboratories, National Oceanic and Atmospheric Administration, Boulder, CO; Mary Carter, Deputy Administrator, Agriculture Research Service, U.S. Department of Agriculture, Washington, DC; and John Cooper, State Director, North Carolina Agriculture Stabilization and Conservation Service.

If you would summarize your statements, your entire statements will appear in toto in the record.

Mr. Hooke, would you begin?

STATEMENTS OF WILLIAM H. HOOKE, ENVIRONMENTAL RESEARCH LABORATORIES, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, BOULDER, CO; MARY CARTER, DEPUTY ADMINISTRATOR, AGRICULTURE RESEARCH SERVICE, U.S. DEPARTMENT OF AGRICULTURE, WASHINGTON, DC; RALPH L. PRICE, NORTH CAROLINA AGRICULTURE STABILIZATION AND CONSERVATION SERVICE, RALEIGH, NC; AND HAROLD MANGUM, PROGRAM SPECIALIST, USDA-ASCS, RALEIGH, NC

Mr. HOOKE. Yes. I will be happy to begin.

My name is William Hooke. I am the Director of the Environmental Sciences Group, Environmental Research Laboratories.

I am very happy, Congressman Valentine and Congressman Cobey, to have a chance to speak with you this morning on the subject of weather modification.

By way of introduction, I should mention the Environmental Sciences Group is primarily concerned with the implementation of science and technology that will lead to improvement of weather forecasts on the very short time frame and the small spacial scales that Mr. Fishel just spoke to moments ago.

We are very much concerned with the implementation of Nexrad, with the use of satellite data to provide better forecasting, warnings of tornados, and other severe short-term weather events.

As a small part of our program, we provide support to States who are faced with operational weather modification activities. These States—as we have seen this morning—the States tend to be hit hardest by water resource problems and find themselves confronted with the need to regulate and provide policy formulation in support of weather modification activities within their jurisdiction.

The events, such as the recent drought bring this kind of interest in weather modification, an interest that has been with us since time immemorial, to the forefront. There is something about suffering, and the way that people do when drought occurs, that makes us think we cannot just forecast what may be going on in the weather, but we might actually be able to do something about it.

In recent years, that interest has grown, as a result of scientific understanding and advances in technology generally, but also because it is becoming clear that, inadvertently at least, mankind is affecting the weather and the climate locally.

We have heard the term "urban heat islands", that refers to the fact that temperatures are generally somewhat higher in urbanized areas than they are in the surrounding localities.

We have learned through study that the impact of automobile exhaust, the impact of oil refinery operations and other economic activities of mankind, can affect cloud size, cloud drop size distributions, and the prospects for the availability of moisture in clouds.

So it is one small step from that notion to the notion that it might be possible to intervene directly into cloud processes and change—usually enhance—the amount of precipitation available from a single cloud.

The technology that is used for that is an activity that is referred to as cloud seeding. It is the introduction into the cloud of material that provides preferential sites for the new creation of ice crystals within clouds.

It turns out that ice crystals in clouds will grow preferentially over the water droplets in the cloud and produce particles that are big enough to fall out of the cloud—that can't be maintained in that cloud by its natural circulation and—therefore, enhance the opportunities for precipitation. The operational weather modification folks in this country seed clouds with that kind of precipitation enhancement in mind.

Now, how well does that work?

When we are talking about weather modification, we are talking about a very young technology. Like most young technologies, it has more success in certain applications than in others.

One application where there has been a quite clearly demonstrated success is the use of seeding to disperse super-cooled water droplets that create fog and inhibit the operation of airports.

That turns out to be a fairly well established technology. If we proceed in the direction of greater uncertainty, we come to the seeding of so-called orographic clouds and precipitation events—weather that is produced by the air flow over a mountain—the lifting of the air by the mountain and the precipitation associated with that.

The Western States who receive the bulk of their precipitation through such orographic events are looking at the use of weather modification activities to enhance that precipitation by a few percent.

At the extreme end of the uncertainty spectrum is the modification of convective clouds, the cumuliform or cauliflower-looking clouds, that provide the genesis of thunder storms and most of the growing season rainfall.

These storms are inherently unstable. They are inherently difficult to predict. It is almost impossible to predict in the case of an individual storm, what that cloud will do in the absence of any modification and it is, therefore, quite difficult to predict what effect you had on it by modifying such a storm.

There are attempts to do that, but we have to evaluate those attempts on a statistical basis. We can't do it on a case-by-case basis. We find in the case of operational cloud seeding experiments that it is impossible to provide such an evaluation. We have to use randomized seeding procedures in order to evaluate that success.

So when we are talking about summertime cloud seeding we are talking about a technology that I think is operationally some time away from us in terms of being useful in the whole scale kind of sense that is required to successfully address North Carolina's problem.

In that light, NOAA has focused its activities on research designed to improve the diagnostic power of the scientific investigations of cloud seeding. Most cloud seeding studies involve seeding the cloud and essentially holding out our hands to find out how much rain we got.

That rain is the tail end of a process that contains a number of steps and what we have tried to do in NOAA instead is look at the immediate effects of the cloud seeding, use in situ samplers or chemical tracers, or use remote sensors to look at the first changes in the cloud particle type that result from the introduction of the seeding agents.

We believe that we have changed the shape of weather modification research in this country by introducing such technologies into this field. We look forward to working with the Congress, and with the American people to continue to develop this technology over the coming years.

Thank you very much.

[The prepared statement of Mr. Hooke follows:]

TESTIMONY OF

WILLIAM H. HOOKE
DIRECTOR, ENVIRONMENTAL SCIENCES GROUP,
ENVIRONMENTAL RESEARCH LABORATORIES
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
U.S. DEPARTMENT OF COMMERCE

BEFORE THE

SUBCOMMITTEE ON NATURAL RESOURCES,
AGRICULTURE RESEARCH AND ENVIRONMENT
COMMITTEE ON SCIENCE AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

SEPTEMBER 29, 1986

Mr. Chairman and Members of the Subcommittee:

I am happy to have this opportunity to appear before you near Raleigh, North Carolina - my birthplace - to speak on the development, evaluation, and use of weather modification technologies to enhance precipitation.

I direct the Environmental Sciences Group (ESG) of the National Oceanic and Atmospheric Administration (NOAA). ESG includes the Program for Regional Observing and Forecasting Services (PROFS), the Weather Research Program (WRP), and the Weather Modification Program (WMP). ESG conducts coordinated programs of weather research and technology development aimed at improving the weather services NOAA provides this country. In addition, we have been working cooperatively with research institutions in several States nationwide, helping them

develop the understanding and information base they need to formulate policy and regulations with respect to commercial cloud seeding and other weather modification activities within their respective jurisdictions.

The recent drought in the southeastern States has brought home forcibly to all of us once again our critical dependence on a precious but elusive atmospheric resource - water. While the farming sector is the most dependent on the availability of water, other sectors of the economy - such as hydroelectric power generation - are similarly dependent, as illustrated by the effects of the recent dry spell on the Tennessee Valley Authority (TVA) operations.

In a very real sense, NOAA is a water resources agency. We have statutory responsibility for monitoring and forecasting the form and amount of precipitation (or lack thereof). In addition, NOAA issues stream and river nowcasts and forecasts nationwide.

Such forecasts constitute one of the greatest challenges facing modern science. To fulfill our mission entails:

- a fundamental understanding of the broad array of atmospheric processes - dynamical, microphysical, radiative, electrical, and chemical - that produce clouds and precipitation, as

well as a similarly broad range of hydrological processes that shape the terrestrial response;

- an ability to observe these processes with the requisite nationwide coverage, and fine resolution in space and time;

- credible, reliable conceptual and numerical models which are able to simulate and forecast precipitation and its hydrological consequences;

- computer and digital telecommunications systems which are able to integrate, assimilate, archive, retrieve, display, and disseminate this information;

- National Weather Service personnel who are experts at providing such services to the American public.

This is a difficult challenge, which is enhanced by research and development efforts supporting the modernization and restructuring of the National Weather Service.

If forecasting is difficult, then purposeful weather modification is more difficult still. It requires not only an ability to forecast the evolution of the weather in the absence of any attempts at modification, but also a quantitatively accurate understanding of the modification procedure itself.

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Present weather modification efforts typically focus on cloud seeding - the introduction of particulates such as dry ice or silver iodide in the cloud to enhance ice nucleation and the subsequent growth and precipitation of these cloud ice particles.

Weather modification is a young technology, with a mixed record of success to date. Success in supercooled fog dispersal has been demonstrated and is used operationally at numerous airports. Cost-effective mountain snowpack enhancement of a few percent appears to be feasible, with several opportunities for application in the western States.

By contrast, demonstrating effective modification of convective clouds, of the sort responsible for most growing-season precipitation, has proven extraordinarily difficult. Past experiments in the United States, such as NOAA's Florida Area Cumulus Experiment (FACE), have generally failed to attain the success reported in some foreign countries, notably Israel. The difficulty is an intrinsic one, inherent in the fundamental instability underlying convective processes, by contrast with the predictability of snow or rain forced by the airflow over mountainous terrain. Precipitation gains on the order of ten percent, such as those reported in the most optimistic studies, are masked by the enormous natural variability in the background population of convective weather events. At present, it is

impossible to say with any confidence that precipitation coming from a particular seeded convective cloud was enhanced by the seeding, let alone to assess the size of the effect. Seeding effects can only be estimated in a statistical sense, by comparing extensive populations of seeded versus unseeded clouds. Advances in this area will come slowly, if at all.

In the coming decades, the United States will continue to experience a series of national, regional, and local water resource crises of varying degrees of intensity and urgency. The problem will not go away. Moreover, in considering the efficacy of weather modification as a societal response to drought, we must bear in mind the policy and technology alternatives. These include: technologies and land use practices affecting runoff; the building of dams and reservoirs and other efforts to increase storage; desalination; interstate diversion and transport of water; dryland farming; simple conservation; and genetic modification of plants and animals. Each of these alternatives provides only incremental enhancements; suffers from its own set of uncertainties; requires an immense capital investment, or wrenching changes in societal behavior, or further research before it can be truly effective; and generates its own share of debate and controversy.

Thus, when weighing the alternatives, States, weather-sensitive sectors of the economy (e.g., agriculture), and certain individuals will continue to find weather modification attractive. They recognize it is not a panacea; but none exists. They view weather modification as a single component of a broad-spectrum water-resource management strategy.

Given the present level of uncertainty in our understanding, NOAA has chosen to give its priority to support of research rather than to operational weather modification programs. Our efforts have focused on basic studies of the interaction between microphysical and dynamical processes, in both orographic and convective situations. We have tied our studies closely to related efforts to improve quantitative precipitation forecasts. During the last few years, by developing and using chemical tracer technologies and remote sensing instruments of remarkable diagnostic power, and by subjecting the results to rigorous statistical analysis, we have made great strides in our fundamental understanding of cloud evolution and development.

For example, researchers have used chemical tracers to "tag" seeded areas of cloud, together with a wide variety of particle measurement systems to evaluate different methods for seeding dispersal and to verify the effectiveness of different cloud nucleating agents. Research has demonstrated a great

variability in the speed of different seeding materials, and has identified some showing special promise. Tracers have been used to distinguish between nucleation processes, in which the seeding agents initiate precipitation particle growth, from scavenging processes, in which the seeding material is passively swept out of the cloud by pre-existing snow and water particles. Microwave radiometric techniques have been used to detect supercooled liquid water in clouds (an important indicator of aircraft icing hazard as well as cloud seedability), and to monitor the change in liquid water content following introduction of seeding agents. Using polarization diversity lasers and radars, researchers have been able to detect cloud responses to seeding (e.g., change from supercooled liquid water droplets to the ice phase).

This research has been credible and influential in shaping the design and implementation of cloud physics research nationally and internationally. For example, the use of tracer and radiometric technologies, unknown a few years ago, has become standard procedure in serious experiments. By maintaining one core program of weather research to support the National Weather Service, we intend to continue to work together with other Federal agencies, with the Congress, and

with the research community to hasten a day when drought will no longer be able to inflict such pain and suffering on the American people.

Thank you again for giving me this opportunity to testify. I am prepared to address questions which you might have concerning my testimony.

Mr. VALENTINE. Thank you very much, Mr. Hooke.

Dr. Carter.

Dr. CARTER. Thank you, Mr. Chairman, and members of the subcommittee.

I am Mary E. Carter, the Associate Administrator of the Agricultural Research Service of the U.S. Department of Agriculture.

I appreciate the opportunity to appear before you and to discuss the research that ARS, as I frequently refer to our agency, does, which is designed to mitigate the effects of drought.

The first point that I would like to make is that ARS is a national research agency and we have research centers in various climatic zones across the United States. All of the research that is done is to develop drought resistant technology and improved irrigation systems. This technology is developed in areas where it is possible to carry out such research and all of this research is largely transferrable to the southeast areas.

Now, implementation of drought resisting, mitigating technologies, often requires significant investment before the drought occurs. At the present time, to enable farmers to assess investments, whether such investments will return profits, we are working on a computer model down at our ARS Southern Piedmont Conservation Research Center in Watkinsville, GA.

Now, some of the technologies that we develop and which require lease cost, of course, involve the use of drought resistant crops. Such crops can include drought-tolerant cotton variety. As a result of a severe drought back in Montana in the 1970's and 1980's, we were able to evaluate some grasses we found very good, and these grasses, besides being drought tolerant, provide good forage yields, even in normal rainfall areas.

We have some alfalfa with a waxy coating which is very good, which was developed out in Logan, UT and Manhattan, KS. We have a soil-born fungus which will help soybeans withstand drought conditions.

We have done some work in Colorado using an antigiberelin which will increase corn yields as much as 15 percent, even in drought conditions. Someone has already mentioned reduced tillage research. We have done a considerable amount of this both in Coshocton, OH and Kimberly, ID, and we know from the results of this that we have increased earthworm populations and more burrowing activity and this aids an ability of soil to absorb water.

Our studies have shown that the primary factor that causes droughts to reduce crop yields in the southeast, however, is generally shallower rooting of crops than we have in other parts of the United States.

The reason you have this shallower rooting is because soils are compact and you have acid subsoils. We have done this work relating to shallow rooting both in the coastal plains and the Piedmont region of the southeast and we have found from work done in Florence, SC ripping the soil to these subsoils has led to increased rooting and, therefore, to making more water available during drought stress conditions.

Of course, always we will be using the tools of biotechnolgoy and trying to identify genes that control root characteristics and then capitalizing on that information such that we can, through genetic

engineering, develop root systems that will enable plants to have better drought tolerance.

One of the key points that I think we should recognize is that all of these technologies that I have talked about require implementation prior to the drought in order to mitigate the effects of drought.

In many instances where we have water available and where we have high value crops that can be grown and marketed, then, of course, irrigation is a viable solution of the drought problems.

Now, drought related research programs are planned with inputs from farmer organizations and action agencies such as the Soil Conservation Service.

We carry out these research programs in cooperation with these groups, with universities and State experience stations. We continue to work with the Soil Conservation Service and the State Extension Service in order to achieve rapid dissemination of management technology and other types of technologies that will be useful in mitigating droughts.

Thank you, sir.

[The prepared statement of Dr. Carter follows:]

STATEMENT OF

DR. MARY CARTER

ASSOCIATE ADMINISTRATOR

AGRICULTURAL RESEARCH SERVICE

U.S. DEPARTMENT OF AGRICULTURE

BEFORE THE

SUBCOMMITTEE ON NATURAL RESOURCES, AGRICULTURE RESEARCH AND ENVIRONMENT

OF THE COMMITTEE ON SCIENCE AND TECHNOLOGY

U. S. HOUSE OF REPRESENTATIVES

AT

RALEIGH, NORTH CAROLINA

SEPTEMBER 29, 1986

Mr. Chairman and members of the subcommittee, I am Mary E. Carter, Associate Administrator, Agricultural Research Service (ARS) of the U.S. Department of Agriculture. I appreciate the opportunity to appear before you to discuss this year's drought in the Southeast and ARS research designed to mitigate effects of drought.

As a national research agency, the ARS has research centers in the various climatic zones across the United States. In the West, precipitation generally limits crop production which provides natural conditions during most years for our studying the response of crops to drought. Drought-resistant technology and improved irrigation systems developed in those areas are largely transferable to the Southeast.

Implementation of these drought mitigating technologies often requires significant investment before the drought occurs. To enable farmers to assess whether such investments will return profits, a computer model is being developed at the ARS Southern Piedmont Conservation Research Center in Watkinsville, Georgia. This model will incorporate records, from weather stations near the farm, from which probabilities and severities of drought can be estimated. The model will also estimate crop yield reductions due to droughts with and without the mitigating technologies.

Some of the technologies whose implementation appears to require the least cost involve use of drought-resistant crops. Excellent drought resistance due to an expanded and deeper rooting system has been developed in a barley variety by ARS scientists in Tucson, Arizona. Most newer varieties of wheat for the Great Plains have genetically built-in drought resistance.

Similarly a drought-tolerant cotton variety has been discovered by ARS scientists at Lubbock, Texas. This variety has smaller leaves and a more dense root system than normal cotton. Research is continuing to try to incorporate this drought-tolerant characteristic into a top yielding variety.

The severe drought in 1979 to 1981 in Montana enabled our scientists to evaluate drought tolerance of many grasses. Western wheat grass survived and gave better yields at Miles City than other grass during those drought years. It can also provide good forage yields in normal rainfall years.

Alfalfa with waxy coating on its leaves is being developed at Logan, Utah, and Manhattan, Kansas. This waxy coating reduces rate of water loss from the plants and should help new alfalfa varieties perform better during droughts.

A soil-borne fungus has been used by ARS scientists at Lincoln, Nebraska, to achieve better yields of soybeans under drought conditions. The fungus increases production of a hormone which stimulates root hair growth, enabling plants to make better use of water in the soil.

In Akron, Colorado, a chemical (antigiberelin) has increased corn yields under drought conditions by 15 percent. Applied soon after emergence, this chemical slows early growth of corn. Later in the season, when the ears are forming and the effect of this chemical wears off, roots penetrate lower depths of the soil where water is still available.

Increasing the intake of precipitation by soils has been one of the consistently best means of storing more water in soil to meet later drought periods. Since this also reduces runoff and erosion, means for its accomplishment have been developed in ARS research centers in higher rainfall areas including the South and Southeast.

In Bushland, Texas, furrow dikers have converted furrows to basins which hold water on the surface until it has time to infiltrate.

Leaving crop residues on the soil surface protects soil from raindrop impact and maintains intake rates higher than on bare soils. Long-term studies at ARS locations in Coshocton, Ohio, and Watkinsville, Georgia, have shown increased intake due to leaving residue on the surface of one to nine inches of water per year and averaging about four inches. These residues also reduce evaporation of water from the soil which adds to the water supply available for crop growth during later droughts.

Reduced tillage in Coshocton, Ohio, and Kimberly, Idaho, has resulted in higher earthworm populations, more burrowing activity, and persistence of the burrows which increase the ability of soils to absorb water from puddles which tend to form on the surface during heavy rainfalls. These burrows move water deeper into the soil where it is less susceptible to evaporation and more likely to be available during following droughts.

Our studies have shown that a primary factor causing droughts to reduce crop yields in the Southeast is generally shallower rooting of the crops than in other areas of the U. S. Compacted and acid subsoils have been identified as primary causes of shallow rooting in the Coastal Plain and Piedmont regions of the Southeast. Ripping the soils to open these compacted subsoils to roots was found to increase rooting depth and water available during droughts at Florence, South Carolina. This practice, adopted by many farmers in this Coastal Plain area, was credited with preventing a total loss of the crop during last summer's drought.

A conference organized by the ARS at Beltsville Agricultural Research Center in 1975 identified many crop species and varieties which have exceptional tolerance to and ability to penetrate acid subsoils. Physiologists, crop breeders, and soil scientists are working together at Beltsville and other locations to incorporate such tolerance into high yielding crop varieties. Tolerance of acid subsoils allows the roots to extend deeper and mine water from a larger soil volume. It does not appear to cause a built-in reduction of yield during normal water years.

Genes that control root characteristics have been identified and are being studied by ARS scientists to determine the potential for genetically engineering root systems which will enable plants to better tolerate drought.

Most of the above technologies require implementation prior to the drought to mitigate effects of the drought. One which could be installed during the drought helped many farmers in the Coastal Plain in the vicinity of Florence, South Carolina, escape consequences of the drought. Portable collapsible dams developed by the ARS at that location were installed on many open drains. They allowed farmers to raise the water level in those drains and adjacent lands, providing crops on those lands with water. In some cases, contributing tile drains acted in reverse to their normal function and helped carry water from these dammed open drains back into the fields and raise the water table to the plant root zone. In other cases, the dammed drains served as water sources for sprinkler irrigation.

The drought was so severe in the Florence, South Carolina, area that only farmers who had such alternate sources of water were able to obtain reasonable yields.

Irrigation from dammed drains, farm ponds, and groundwater was able to save crops on between one and two million acres of land in the Southeast last summer. Most of this irrigated land is in Florida and southern Georgia. Where sources of water are available and high value crops can be grown and marketed, irrigation is a viable solution of the drought problem. In those areas, the irrigation systems and management practices developed by ARS scientists and engineers in the West are being adapted to the topography, climate, soils, and crops of the Southeast and are providing a permanent solution to the drought problem.

Our drought-related research programs are planned with inputs from farmer organizations and action agencies such as the Soil Conservation Service. Many of these research programs are conducted in cooperation with those groups, universities, and State experiment stations. Existence and continued functioning of the Soil Conservation Service and State Extension Services are essential to the rapid dissemination of the management technology which ARS has developed and is developing to mitigate effects of drought.

Mr. Chairman, this concludes my testimony. I will be pleased to answer questions which you or other members of your subcommittee may have.

Mr. VALENTINE. Thank you, Doctor.

Mr. Price.

Mr. PRICE. It is indeed a pleasure to be here before you today to testify concerning the aspects and the implementation and programs through the United States Department of Agriculture ASCS Office, that is, Agricultural Stabilization and Conservation Service.

The State executive director, John J. Cooper, was unable to be here today so he has asked myself and H.B. Mangum, who is in the audience here, to appear on his behalf and answer any questions possibly you may have.

He has prepared a statement and I would like to read that to you. It is a brief statement and it has been presented for the record already.

Mr. VALENTINE. Would Mr. Mangum, would you come around, please, sir?

Mr. PRICE. If it is OK with you, he could answer any questions also.

Mr. Mangum has been around for a while with ASCS and knows about the State of North Carolina quite well.

Mr. VALENTINE. Welcome, sir.

Mr. PRICE. This statement starts off, this drought is recognized as being one of the most severe in the area during the 20th century. Indications of a drought appeared after there had been a shortfall of rain during the winter and early spring suggesting the possibility of a drought.

By mid-July it was apparent to USDA officials that the southeast was in fact experiencing severe drought conditions.

Secretary Lyng directed Assistant Secretary George Dunlop to form a task force to view the drought conditions in Georgia, Alabama, North and South Carolina. Assistant Secretary Dunlop along with three other USDA officials toured the four affected States on July 20 and 21 to gain a first-hand understanding of the severity of the drought and reported the findings to the Secretary.

Based on the findings of the task force, Secretary Lyng dispatched additional fact-finding teams to other areas of the southeast and formed a Drought Assistance Task Force within USDA to provide for broader coordination among Federal officials, State officials, and the agricultural community.

Secretary Lyng appointed Deputy Assistant Secretary, James B. Boillot as Drought Coordinator and established a nation-wide toll-free hotline to respond to requests for information or assistance with drought related questions. In addition, Secretary Lyng implemented the following programs to provide assistance to farmers in the drought affected states:

One, permitted the haying and grazing on acreage set aside under the acreage conservation reserve requirements of the various commodity programs.

Two, provided that acres designated for conservation use under the acreage conservation reserve requirements could be planted for winter pasture.

Three, allowed farmers to harvest drought-stunted crops for forage and maintain their eligibility for deficiency payments.

Four, provided cost-sharing assistance to farmers for the re-seeding of pastures that have been severely impacted by the drought.

Five, provided that cost-sharing assistance be available to re-establish stands of newly planted pine trees lost due to drought conditions. The Secretary further announced that, as rapidly as possible, USDA would expedite requests from Governors of affected States for secretarial designations as disaster areas.

Under a secretarial designation a farmer can qualify for Farmers Home Administration emergency loans, EM, or the Emergency Feed Assistance Program, EFAP. To date 546 counties from 12 Southeastern States have been designated disaster areas.

On August 1, Secretary Lyng announced additional programs of assistance to southeastern farmers. These programs include:

One, Feed Cost-Sharing Program which provides for the cost share of up to 50 percent or 5 cents a pound of feed costs of purchased feeds on a feed/grain equivalent basis.

Two, Commodity Credit Corporation, CCC, would begin moving grain from storage facilities in the Midwest to facilities in the Southeast for distribution throughout the area to assure availability of adequate feed supplies.

Three, generic certificates in cost-sharing payments to allow the further conversion of cost-share payments to grain for livestock feed.

Four, increased 1986 advanced deficiency payments across-the-board, an additional 10 percent to all program participants.

These programs made available immediate assistance to farmers in the drought affected States.

Mr. Chairman, it may be of interest to the committee to review how farmers, railroads, truck lines, and others provided assistance to livestock producers in the southeast on a volunteer basis.

I refer to the donation and aircraft transportation of hay from Illinois to South Carolina. To date, an estimate in excess of 70,000 tons of donated hay have been moved into the southeast, free of charge. Over 5100 railroad cars have moved hay from as far west as California, Oregon and Washington, and as far north as New Hampshire and Maine. Hay donations resulted from the generosity of farmers across the Nation and close cooperation and coordination among farmers, industry, State and Federal Government officials.

The drought in the southeast was severe and long-lasting. The rains in August and September have been of substantial benefit; however, it is recognized that the impact of the drought was not alleviated by these rains.

We are program specialists in the ASCS office with respect to the Emergency Feed and Emergency Feed Cost Share Program.

Mr. Mangum is a specialist on the Agriculture Conservation Program and how that was related to the receiving of pastures and so forth. That is all I have. Thank you.

[The prepared statement of Mr. Cooper follows:]

JOHN COOPER, DIRECTOR
Agricultural Stabilization and Conservation Service
United States Department of Agriculture
before the House Committee on Science and Technology,
Subcommittee on Natural Resources,
Agricultural Research and Environment,
September 29, 1986.

Mr. Chairman and Members of the Committee:

I appreciate the opportunity to appear before you to discuss the various steps and programs which the United States Department of Agriculture (USDA) has implemented in response to the drought in the Southeast. This drought is recognized as being one of the most severe in the area during the twentieth century. Indications of a drought appeared after there had been a shortfall of rain during the winter and early spring suggesting the possibility of a drought. By mid-July it was apparent to USDA officials that the Southeast was in fact experiencing severe drought conditions. Secretary Lyng directed Assistant Secretary George Dunlop to form a task force to view the drought conditions in Georgia, Alabama, North and South Carolina. Assistant Secretary Dunlop along with three other USDA officials toured the four affected states on July 20th and 21st to gain a first-hand understanding of the severity of the drought and reported the findings to the Secretary.

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The drought in the Southeast was severe and long-lasting. The rains in August and September have been of substantial benefit; however, it is recognized that the impact of the drought was not alleviated by these rains.

Mr. Chairman, I appreciate the opportunity to have shared this information with you and welcome questions that you may have.

Mr. VALENTINE. Mr. Cobey, did you want to make a statement at this point?

Mr. COBEY. I enjoyed your excellent testimony and appreciate your coming here.

I am going to have to leave here and leave it in the able hands of my distinguished colleague, Mr. Valentine.

Please excuse me.

Mr. VALENTINE. Thanks for coming, Bill.

Mr. Price, we are not here, of course, to attempt to elicit any criticism of any group or some other group. We are not here to level any—that is just not the spirit or intention of this hearing.

But one of the earlier witnesses had made some suggestion that there might have been something that the ASC's office in that particular county could have done differently from what it did do. Did you hear that, and would you care to make any response, you or anyone of you.

Mr. PRICE. Yes, sir. I will start and if Mr. Mangum has anything to interject, he can do so.

I would appreciate it. Mr. Wagstaff made the statement in his county he had applied for disaster assistance through the Emergency Feed Cost Sharing Program.

As the program was set up, we had two options. We could take the amount of loss that producer had from the date of application through the beginning of the harvest of his crops or we could do an alternate method and take it from the date of application and go through the end of the crop year which is established as the first grazing available in the spring.

Most of the people, the producers, have requested to go the alternate method so they could get the entire feeding period of approximately 200-plus days instead of going the short term in which they would only go for about two or 3 weeks before harvest started.

That would enable them to receive additional time to have their losses computed. All the losses are computed on a production loss basis so that that was to take place within the short term, that from the date of application to the beginning of the harvest, would only have benefited the farmer as far as hay loss or pasture loss would have gone.

Those that would go and opt for the alternate method would have their pasture and their corn and everything included on an estimated basis, make them eligible tentatively for feed purchased after the date of application and they would therefore have that cover for the duration of the feeding period up through the end of the crop year.

It is true the program requires that the actual production be figured and a loss determined at that time. So on the alternate method we have to wait to do the actual computations until after all production has been harvested.

Therefore, we cannot cost share until actual production losses have been determined. So in his reference there are some payments being made, but there are a lot of payments that are not being made until the farmers have harvested all of their crops. But the farmers have cost share assistance on any feed that they buy after the date of application if they were tentatively approved.

Mr. VALENTINE. You mentioned something, Mr. Price, about a nationwide hot line for drought-related questions. Was that used very much this past summer?

Mr. PRICE. Sir, it would be difficult from my left to address that use of the hotline itself. We do know there was information available concerning the program, such as the SB–51 Program for reseeding of pastures, the availability of agriculture conservation and forest tree improvement cost share moneys for reseeding pastures under a different program and also reseeding or replanting trees.

We also know there was information available on the emergency feed program, the emergency feed cost share program, and other programs as far as the advanced deficiency payments and things go with ASCS.

Mr. VALENTINE. Do you have an estimate you regard as reliable as to what this catastrophe cost American agriculture in dollars and cents?

Mr. PRICE. We have unofficial estimates and in North Carolina we do have an estimate of $330 million.

Mr. VALENTINE. Do you think there was significant permanent damage to standing timber?

Mr. PRICE. We do not have any estimates. That will be a question the Forestry Service will be better able to answer, I believe, sir.

Mr. VALENTINE. Mr. Price, kind of semipersonal observation. Wasn't this drought, at least in North Carolina, a spotty situation? It seemed to me to be areas around my home where 10 miles down the road there was plenty of rain and, in fact, it was around just here, there. What do you say to that?

Mr. PRICE. Very true, sir. The rains came in certain areas and did not come in other areas of the same county. Also, in the mountains there were rains in certain parts of the county in which a cloud would come around the mountain and dump rain in one valley but would miss several other valleys in the same county.

As far as the State of North Carolina as a whole, the drought affected approximately 79 counties as we have designated for disaster. The eastern part of the State was not affected nearly as much as the central and western part of the State.

The eastern part of the State does maintain a great deal of the farming that goes on as far as corn, soybeans and tobacco farming and their crops are estimated in fair to above-average conditions and they are harvesting record amounts of crops, corn, right this moment in the east.

Mr. VALENTINE. Mr. Hooke, on this question of creating artificial precipitation, I guess that is what it would be, cloud seeding and so on, has that been tried extensively in the Eastern part of the United States or is that an experimental program that is restricted almost entirely to the West?

Mr. HOOKE. My understanding is not first hand, but it appears that the vast majority of these seeding experiments are done in the West. From the records that I have seen, the last time it was tried in North Carolina was 1957. That does not mean that there haven't been operations since then. I am saying that is when the records I have seen.

There have been some seeding operations in Georgia that were carried out during the 1977 drought, but there are very few operations in these States compared to what we see in the West.

Mr. VALENTINE. Has the technology really ever proved itself?

Mr. HOOKE. Let me look at this question in the following way. There was another bit of technology that was introduced in North Carolina in 1903. That was the invention of the airplane. I think it would be possible in 1923 to look at the following situation.

We would have had a lot of fellows who were flying around the barn and giving people rides for $5 a plane ride and they would be saying this is the peoplemover of the future, but it would be possible in that year to say it has been 20 years since the airplane was invented and it is not readily apparent.

That is the way that the transportation technology was going. Now, in 1923, the Ford Trimotor was invented and that was one of the first airplanes where people looked at the airplane and said I believe if I get in that airplane in Cincinnati, I can get out in Tulsa.

So I think that as I said earlier, you are looking at a young technology. In fact, you are dealing with a more complicated problem than the problem of flight.

It is clear that it is possible to impact weather events. It is also clear that we are far away from being able to control weather events. So that is the kind of State that the technology is in.

Mr. VALENTINE. Well, so what you are really saying is there might be more hope for some improvement in the situation than some would expect, if you relate this to aviation.

Mr. HOOKE. There has certainly been a lot of impact in that case. I am not going to forecast the technology is going to change today, but I do believe that weather modification is something that needs to be investigated.

I think it is interesting to compare weather modification to the policy and technology alternatives and I am not an expert on any of these, but we have looked at a suite of activities, including the building of dams, the change of our land use practices to affect runoff, desalination of water supplies, the genetic modification of plants and animals, the interstate transport of water from one State to another, and I think in each of these cases we are looking—and weather mod—we are looking at a technology that is incremental. We are buying a few percent here or a few percent there. We are looking at a technology that is costly. It is going to cost a great deal of money either in capital investment in the case of some of these dams to get what we want, or in the case of desalination it is costly in energy terms to remove the salt from water.

We are looking at technology that is uncertain and we are looking at a technology that is going to arouse a great deal of debate and controversy. None of these technologies that I mentioned is going to do anything but generate more hearings.

You are going to have a lot of people testifying on both sides of each of these issues. So I think weather modification has to be seen as part of a package.

We agree that water resources are going to be a consuming national interest for the rest of our lives. We are going to live the rest of our lives punctuated by a series of crises of varying degrees of

intensity, both locally, regionally or nationally, with the question of water resources and their availability and we have to see—we are going to be considering all of these technologies and trying to move as rapidly as possible in each of them to address that problem.

Mr. VALENTINE. And if we develop the technology, if we could just send an airplane up and seed a cloud and have it rain in a certain period, we could make sure it would rain just on the just. Now it rains on the just and unjust.

Mr. HOOKE. I am counting on it raining on the unjust.

Mr. VALENTINE. Are you familiar with the technology in the State of Israel?

Have not they, necessity being the mother of invention, and they are at a place where they had to if they were to survive, they had to make the desert bloom. Haven't they gotten into this business of artificially induced rain to a greater extent than we have in this country?

Mr. HOOKE. Yes, that is absolutely correct. My assessment is they are far more advanced in their water resource management generally than we are. Their irrigation practices and their use of water generally is quite well managed because they have, as you pointed out, a rather urgent problem.

In the case of weather modification activities itself, I think you are also correct in saying that the State of Israel seems to have been more successful in not only the modification of clouds, but in the demonstration and incredible scientific way that those clouds were successfully modified than we have been as a rule in the United States.

There are probably several reasons for that. One is they have put a fairly substantial effort into it.

Second, their effort has been a scientific effort. The scientists have been involved from the beginning. It is not simply a set of commercial operators who are carrying out this work.

There is a hand-in-glove kind of cooperation between people doing the statistical analysis of the events, randomizing the seeding and so on, kind of cooperation between those folks and the folks actually doing the seeding.

Furthermore, Israel is a small country. It does not display the variety of meteorological conditions we see here, at least in very short periods of time.

There are simpler meteorological regimes to deal with. There is not the rather complex situation that we face.

Mr. VALENTINE. Thank you, sir.

Doctor, just a couple of questions. What effort does your agency make to get information on drought resistant crops out to farmers and producers?

Dr. CARTER. Our technologies are transferred in any variety of ways, sir. Extension Service is an excellent methodology for transferring technologies. Private industry, of course, who picks up some of the technologies with regard to drought resistant strains and then they go ahead and develop commercial varieties.

So they, in turn, are transferring some of the technology to the farmer. The Soil Conservation does an excellent job. We cooperate quite extensively with the Forest Service and any technologies, of

course, with regard to water management and drought, particularly on certain types of lands would be transferred there.

We work closely with the Corps of Engineers. We work with the Bureau of Land Management, et cetera.

Mr. VALENTINE. Doctor, has the ARS examined the usefulness in the United States of the so-called drip irrigation techniques which are commonly used, as I understand it, in Israel?

Dr. CARTER. Yes, we have. I have an example in my testimony, I believe, which are in cooperation with Clemson, some work going on there, using drip irrigation. It is specifically mentioned.

As I say, this is a very feasible thing to do in instances where you are dealing with high value crops and you will find that it is an economical way to go back farming.

Mr. VALENTINE. What is meant by, in a few words, by drip irrigation?

Dr. CARTER. This is supplying water specifically to around the roots of the plant. It is every plant so you are using less water.

You are concentrating the application of water on each plant level rather than flooding the whole field. This involves, as the Israelis can explain quite well, involves greater capitalization cost but more efficient use of your water and they feel this is economic for them.

At the present time many of our areas of the country where we use irrigation, this capital cost is not viewed as necessary yet because there is a reserve supply of water that can be used for irrigation.

Mr. VALENTINE. You mentioned something about, as I understand it, about ripping the soil and turning—piercing this clay surface and getting down to a different type of soil.

Dr. CARTER. Yes.

Mr. VALENTINE. Is that the same thing as deep plowing or plowing with a chisel where you go down into the ground maybe 2 feet or more?

Dr. CARTER. I would assume so—not being a soil scientist—this is what we would expect you would have to do.

It would depend on your situation. The work that I was referring to has been carried out down in Florence, SC.

We have had very good success with this as one of the agronomic practices that will enable the soil to conserve more water and allow the plants to develop deeper roots so they can utilize that water down there, better utilize.

Mr. VALENTINE. Well, we thank you very, very much.

That is the last panel. These are the last witnesses.

I want to thank all of you for coming. I think this has been very helpful. You were all well prepared and I really believe this has been quite a meaningful exercise.

For the sake of the media folks, they might want to grab some of you and talk to you, so if you have time to hang around here, we would be grateful.

Thanks again to all of you for coming.

The hearing is adjourned.

[Whereupon, at 12 noon, the subcommittee adjourned subject to the call of the Chair.]

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